COMPARATIVE ANALYSIS OF TRADITIONAL VERSUS COMPUTER-BASED SURVEY INSTRUMENT RESPONSE

THESIS

Albert E. Franke IV, Captain, USAF

AFIT/GIR/ENV/01M-08

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U. S. Government.

AFIT/GIR/ENV/01M-08

COMPARATIVE ANALYSIS OF TRADITIONAL VERSUS COMPUTER-BASED SURVEY INSTRUMENT RESPONSE

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Systems Management

Albert E. Franke IV, B.A.

Captain, USAF

March 2001

AFIT/GIR/ENV/01M-08

COMPARATIVE ANALYSIS OF TRADITIONAL VERSUS COMPUTER-BASED SURVEY INSTRUMENT RESPONSE

Albert E. Franke IV, B.A.
Captain, USAF

Approved:

Mark A. Ward (Chairman)	8 Feb '01 date
Michael G. Morris (Member)	8 FEB 01 date
Edward D. White (Member)	8 Feb '01 date

Acknowledgments

I would like to thank all the people who helped bring this effort to completion. To my advisor, Maj Mark Ward — thank you for helping me make sense of the endless possibilities, listening to me and gently guiding me through the thesis process. To my reader, Maj Mike Morris — thank you for helping me refine the ideas for my thesis, challenging my ability to think critically and steering me onto the right path. To my other reader, Capt Tony White — thank you for your statistics guidance and helping me make sense of the data not only as a thesis reader but as a respected statistics professor.

As my most important partner on earth, I want to thank my wife—my love, my best friend, and my biggest fan. Her sacrifice, patience, and understanding were critical during those times when I was holed up in my office or at school late at night "playing on the computer." This is the end to the loneliest and most frustrating time in your life. I also thank my daughter [redacted] for her sweet spirit and hugs after a long day, and I thank my son [redacted] for his unending smiles and constant drool. I also thank my parents for their prayers and encouragement.

Most importantly, I would like to thank my heavenly Father and Lord and Savior Jesus Christ who have given me the talents, opened the right doors, and made my life so rich.

Albert E. Franke IV

Table of Contents

List of Figures

Page

List of Tables

Page

Abstract

The purpose of this study was to determine if survey medium (paper versus computer) affected responses and response rates in Air Force personnel. The study compared responses and response rates from 900 randomly selected Air Force active-duty members using a paper-based survey, a computer-based survey, and a more complex computer-based survey. The first computer-based survey minimized the differences between itself and the paper-based survey to more accurately quantify any bias due solely to the computer medium. The more complex survey served to maximize differences between itself and the other computer-based survey to more accurately quantify any bias due to programmatic complexity. In addition, responses from groups stratified on gender (men and women) and military commission (officers and enlisted) were compared between the three survey types. The results showed that no statistically significant differences could be detected between the paper and computer surveys overall and for men, women, officer, and enlisted personnel. In the context of non-sensitive, organizational research, paper and computer surveys can be considered equivalent research mediums with regard to reliability and validity.

COMPARATIVE ANALYSIS OF TRADITIONAL VERSUS COMPUTER-BASED SURVEY INSTRUMENT RESPONSE

I. Introduction

Survey research is considered the most popular and widely used method to conduct social science research today (Babbie, 1990). Not limited to academia, survey research is conducted by a wide variety of organizations from small businesses and marketing companies to government agencies. Survey instruments are often used because of their ability to gather information not possible to be gathered by any other method. Because of the widespread use of surveys, inevitable problems arise that cause criticism to be leveled against the findings of many surveys. In particular, poorly written surveys, poor survey techniques, survey overuse, and survey misuse all have lead to the outright rejection of survey research by many groups and individuals (Babbie, 1990; Hugnagel & Conca, 1994). To combat this criticism, increased attention must be given to survey instrument development and administration to assure that the survey's "significance cannot be doubted" (Parten, 1950:1), in terms of reliability and validity. This thesis focuses on one aspect of modern survey research that has generated controversy stemming from early studies in Computer Assisted Testing (CAT). This aspect concerns the introduction of the computer as a medium to administer surveys and the effects the computer may have on human response.

Background

Traditionally, survey instruments, which encompass the use of questionnaires, polls, and psychological tests, have been administered through a paper-based medium because of the availability, low cost, and acceptance of this most common of informational mediums (Rosenfeld & Booth-Kewely, 1993). The reliability levels, regarding whether questions produce consistent measures in similar situations, and validity levels, regarding whether answers correspond to the measurement under study, of gathering information using a paper medium are often statistically grounded in the research that uses them (Fowler, 1988). As new technologies emerge, researchers must empirically study changes in reliabilities and validities from gathering information through traditional means to gathering information through those new technologies. For example, researchers compared survey results between using paper and the telephone, finding significant differences (Hochstim, 1967; Rogers, 1976). Although intuition suggests that different media might produce different responses, research must document and build a body of evidence to support the equivalency or nonequivalence of the change in survey mediums.

Recently, the accessibility, ease-of-use, and processing power of modern computers have enabled organizations, including many in the Air Force and US government in general, to rely on computer-based surveys, such as the recent Internet-based Quality of Life Survey, much more than a few years ago. It is now quite simple to create a computer-based survey and quickly administer it to a number of people simultaneously on stand-alone computers, Local Area Networks (LANs), or over the

Internet. However, many organizations do not question whether validity and reliability are affected by the new method of administration, which presents a significant problem.

Problem Statement

Using computers to administer surveys may introduce the potential for errors or bias that was previously unaccounted for by researchers. That potential must be empirically assessed. In this context, the computer-based survey medium encompasses the visual presentation, physical manipulation, user and computer processes, and constraints and limitations of using the computer system. Humans are traditionally accustomed to a paper-based medium for practically everything from reading and writing to tests and questionnaires (Rosenfeld et al., 1993). The introduction of the computer to conduct studies once performed using paper and pencil has stirred much debate about the differences in response people have from one form to the other. One study comparing letters written on both paper and computer found that the computer-based writings were "poorer in content quality and total quality" (Haas, 1989:149). Other studies comparing reading comprehension in both the paper and computer mediums found that learning was enhanced through the computer medium (Higgins & Hess, 1999; Horney & Anderson-Inman, 1999). However, Regan (2000:18) suggests that electronic books do not allow for a "pleasant reading experience." How then does the computer medium change how people respond to surveys compared with the popular and traditional paper medium?

Although the future may prove the computer to be the most popular medium rather than paper, the computer, currently, adds an element of unfamiliarity or difficulty for many people (Comley, 2000). Because of this, some people or groups may not want to answer a computer-based survey. This unwillingness or inability to answer can

influence response rates in the form of non-response bias (Kiesler, 1986). At the other end of the spectrum, some individuals and groups may feel more comfortable answering a computer-based survey and may reduce the non-response rate. Some people or subgroups may respond to computer-based survey questions differently than other people or subgroups, intentionally or unintentionally, in the form of response bias (Paulhus, 1991). Response bias is any number of internal and external factors that affect how people answer questions on a survey. These two concepts of bias, which are the dependent variables in this study, will be thoroughly explored in the literature review.

Research Questions (RQ)

This study focuses on three objectives. The first and primary objective of this research is to determine if computer-based surveys are equivalent to analogous paper-based surveys. Two surveys can be considered equivalent if "they produce equal mean scores, identical distribution and ranking of scores, and correlate to the exact same degree with scores on any other variable" (Ghiselli, 1964:227; Honaker, 1988:562). This research will determine if the computer medium introduces significant bias that causes the response rate or mean scores to be significantly different because of the effect of the survey instrument medium. Additionally, this research will attempt to quantify any bias that is due solely to the fact that the survey interface is a computer due to differences in personality, apprehension, difficulty, interference from the computer, or a combination of all these internal and external factors.

The second objective is to determine if format and complexity differences between computer-based surveys introduce additional bias. Cizek (1994) and others found that even the smallest changes to tests could produce statistically different

responses. Altering the position of correct responses on a multiple-choice exam was found to affect user responses to equated examinations. Webster et al. (1996:568) suggest that format and complexity differences affect computer users through an inability to backtrack, increased attention on items when individually presented, immediate and automatic feedback, initial cursor positioning, and "test-taker feelings of a lack of control if answers cannot be changed during computer testing."

The third objective is to determine if particular groups stratified on gender (men versus women) and/or military commission (officer versus enlisted) are affected differently by survey mediums. Previous research into gender and computer technology has shown differences in the way men and women perceive computer technology (Venkatesh & Morris, 2000; Gefen & Straub, 1997). Although no studies in the literature review directly reviewed differences between perceptions of computer technology between officers and enlisted personnel, this study attempts make inferences about these groups based on education level taking into account other differences such as leadership training and military social class differences. Rogers (1995:269) found that people with "more years of formal education" adopt innovations, to include information technology (IT), earlier than those with fewer years of formal education. In addition, Rogers (1995:269) says that those with "higher social status" and "greater degree of social mobility" will use and accept IT much sooner than those lacking these characteristics. These attributes can clearly be associated with members of the officer force at a higher degree than those members of the enlisted force, suggesting that officers should be more accepting of IT and web-based innovations than enlisted personnel.

Based on the stated research objectives, three research questions (RQ) naturally form, whose associated hypotheses will be proposed during the discussion in Chapter 2:

RQ1) Are computer-based and paper-based survey instruments equivalent?

RQ2) Do complex computer-based surveys introduce significant bias into survey responses?

RQ3) Are computer-based and paper-based survey responses or response rates affected by a person's gender or military commission?

Significance of this Study

Academic and vocational researchers cannot assume that the constructs measured with paper-based surveys, polls, questionnaires, or psychological tests can be equivalently measured with a similar computer-based version of the paper-based instrument. While a significant body of research has been conducted regarding the equivalence of different methods of survey and test administration, results have been mixed and sometimes contradictory (Booth-Kewley et al., 1992:562). Additionally, a significant aspect of survey equivalence, the measurement of non-response, has not been adequately addressed in most studies. This study will determine, more accurately, non-response and response bias produced when Air Force members have a choice to complete a survey and self-report on their own time, on their own terms, and without appreciable pressure from the researcher.

Results from this study will help confirm the use of computer-based surveys or disconfirm their use under certain circumstances. If this research shows that there is a difference in how people voluntarily answer computer and paper-based surveys, organizations that create or analyze survey data can make changes to account for these effects. For example, if this research shows that officers tend to over-report positive

feelings on computer surveys, future computer surveys may incorporate questions to control for this tendency. However, if the research shows that there is no significant difference between the two methods, then validity has been strengthened for the use of computer-based survey instruments without prejudice.

With studies like this one, researchers can say with confidence that the results from their computer-based surveys are valid compared with equivalent results from previous paper-and-pencil surveys. Without determining this validity and equivalence, researchers may possibly draw incorrect conclusions from unknowingly biased data causing unfounded policies to be set by those in command.

Scope and Assumptions

The scope of this study is all Air Force active duty personnel who self-report questionnaire responses in a completely voluntary environment. The results do not necessarily apply to all surveys or tests unless they are conducted under similar circumstances. Since the surveys for this study are highly structured, closed-ended, and voluntarily completed without pressure, the findings may not generalize to loosely structured or open-ended surveys administered under controlled environments.

A major assumption in this study is that the paper medium is seen as an insignificant and unobtrusive medium. Every survey introduces some type of bias (Berg, 1954; DeLamater, 1982). This is a major problem found in social science research today, and researchers do their best to control for it. This research will only find any bias due to the change in medium and format that may or may not affect survey reliability or validity. The nature of this research is exploratory; at this point, there is no way of telling whether the computer will have a negative or positive influence on responses.

Thesis Structure

In the following chapter, justification for investigation into the various aspects of differing survey administration and formats will be explored. Special emphasis will be placed on equivalency theories, theories of response effects and bias, survey complexity and format differences, gender differences and military commission differences based on educational, training and social differences in relation to IT. Additionally, a thorough examination of the previous research into the subject of computer versus paper-and-pencil equivalency will be explored. Chapter 3 will explain the research method, the different surveys used to gather data from a sample of Air Force personnel, and the explicit procedures used to conduct the survey. In addition, a review of the analysis techniques to be used on the resultant data will be examined. The final chapters will analyze the actual data from the survey and provide interpretation and discussion of the results. Finally, suggestions will be proposed for further research that could not be addressed in the present study.

II. Literature Review

Chapter Overview

This chapter consists of a literature review of the major constructs, concepts, ideas, and research contributions of survey methodologies that have brought about the research questions and hypotheses proposed in this current study. Because this study is a comparative analysis of possibly different responses elicited by a computer versus a paper survey medium, the concept of survey equivalency (Honaker et al., 1988) will be reviewed as it pertains to types of survey instruments.

Next, the sources of survey error and the constructs of response and non-response bias will be thoroughly decomposed, shedding light on the varying degrees of overall error that can occur. As a further explanation of response and non-response bias, the theories that differences may be found based on format, complexity, gender, and education will be presented.

Finally, this chapter will review previous survey research encapsulating the time period when most of the discussions on the equivalence of computers and paper have surfaced. This review will explicate the weaknesses and strengths in previous research, which led to the questions in this study that require exploration and resolution.

Equivalency and Classical Test Theory

A recurring theme in the study of the computer in the administration of test and survey instruments has been the concept of equivalency. Researchers are primarily concerned with the equivalency of the computer-based format compared to the traditional paper-based format above all other factors (e.g., Hofer & Green, 1985; Kiesler & Sproull,

1986; Honaker, 1988; Lautenschlager & Flaherty, 1990; Booth-Kewley, Edwards & Rosenfeld et al., 1991; Webster & Compeau, 1996; and others).

Under Classical Test Theory, a computer-based and paper-based survey can be considered equivalent if "they produce equal mean scores, identical distribution and ranking of scores, and correlate to the exact same degree with scores on any other variable" (Ghiselli, 1964:227; Honaker et al., 1988:562). This study suggests that response rate should also be identical for the two forms to be considered equivalent in a self-report experimental design. If the response rate (number of surveys returned/number of surveys sent to sample) is statistically different between two methods of administration, some additional and possibly unanticipated factor is causing the difference. Therefore, equivalency of the paper and computer formats of the same survey cannot be automatically solely on Classical Test Theory's definition. Before reviewing the concept of response rates as a factor of equivalency, it is important to discuss Classical Test Theory and each "criteria for equivalency" (Honaker, 1988:561). The three criteria for equivalency are psychometric equivalency, experiential equivalency, and relativity of equivalency (Honaker, 1988:562).

Psychometric equivalency has already been introduced as equivalency based on two formats producing identical mean scores, distribution, ranking, and correlations with other variables. Honaker (1988) states that if these criteria are met, the validity can be generalized from one form to the other. However, Honaker (1988) states that if the criteria are not met, "it is likely that separate constructs are being measured," and validity data cannot be generalized from one form to the other form.

Another concept of equivalency, experiential equivalency, encompasses how two different forms of a test or survey are "experienced by the examinee" (Honaker, 1988). These experiences can be "emotional, perceptual, and attitudinal reactions to the two forms" (Honaker, 1988). In other words, experiential equivalency means that a paper-based survey and computer-based survey can be considered equivalent only if the respondent has the same basic experience while taking the surveys. Because this equivalency is qualitative and very difficult to measure, experience differences can only be assumed to a large degree.

The final concept of equivalency, relativity of equivalence, examines how familiar the survey medium is to the respondent. Relativity of equivalence posits that some groups may have less familiarity with a computer than another group. Because of this unfamiliarity, this group will respond differently than the group that is familiar with the technology. When two groups respond differently to the same survey based on their familiarity with the subject matter, format, or medium, the survey cannot be considered equivalent for the two groups.

Brennan (1983) remarks that standard survey and test instruments that are being administered in both paper and computer formats were originally validated in the paper format using the Classical Test Theory methods. Because of this, it is important to study computer-based instruments using identical methods (Wilson et al., 1985:267). He also notes that by "preserving common methods, the results of current studies can be compared to prior validation studies" meaning that paper and computer surveys need to be validated using the same methods.

Survey Errors

A property of surveys is that human questions measure human answers (Fowler, 1988). Questions are poor measures because they are often unreliable, inaccurate, biased, or cause bias. In other words, they introduce error. Not only do questions introduce error, answers often introduce as much or more bias because of the human response factor. Control and the treatment of error is the problem crucial to all types of surveys (Hyman, 1963). Many authors write about many types of errors: emergent error (Hyman, 1963:179); sampling error (Fowler, 1988); chance, accidental, constant, and non-compensating errors (Parten, 1950:403). However, three main groups of errors can be extracted from all the different labels: random, biased and wrong construct errors. These three groups of errors account for most errors that can be found while conducting a survey and will be fully explained in the following paragraphs.

Error is an often talked about concept in statistical or research methods textbooks. Dooley (1995) explains that any observed score (X) can be decomposed to $X = T + E$, where T is the true score component and E is the error component. This error E can be any factor or measure that makes an observed score different from the true score. Dooley includes the random error (E_r), the biased error (B), and the wrong construct error (E_w). Any other error will be considered too insignificant to discuss for the purposes of this study. So, the new formula looks like this: $X = T + (E_r+B+E_w)$.

Random errors (E_r) are errors that randomly occur, such as errors created from guessing. Because they are random with both positive and negative effects, they will eventually cancel out over many trials (Dooley, 1995:79). Random errors are controlled through two methods: First, the researcher can take great care in instrument design to

reduce the possibility of error. Secondly, the researcher can increase sample size to "obtain the desired statistical power" (Hufnagel & Conca, 1994:50).

Bias error (B) is a nonrandom error and tends to be more complex than random error. Bias exists when an "unmeasured variable skews the results of the measurement process in a systematic way" (Hufnagel & Conca, 1994:51). Bias can be introduced by the researcher, the measurement instrument itself, such as a questionnaire or test, or it can be introduced based on a particular view held by the respondent. A bias error that is in the instrument is less significant than one in the respondent because the bias will be constant across all respondents. The actual observed score may be much different from the true score, but all scores will be consistently affected. The respondent bias may have to do with likes, dislikes or feelings a certain person or group has toward the measurement instrument. In a comparison of bias from a paper-based survey to a computer-based survey, bias error should be noticeable as a difference in observed scores between the two methods. A constant bias will assure any differences are consistently different across the medium.

The third error, error of measuring the wrong construct (E_w), is a major concern in the discussion of equivalency between paper and computer survey instruments. For example, Webster et al. (1996) gave a paper and computer survey to a group of people who had recently completed a computer course. The survey asked the subjects about their feelings about the software and training. Although analysis indicated no mean or reliability differences between the two methods of administration, Webster was concerned that significant differences found in construct correlation was attributed to those subjects who took the survey on the computer. She believes they paid more

attention to the computer and subsequently the constructs such as computer "playfulness" and "experience" took on different meanings compared to those who took the survey by paper-and-pencil. In other words, the subjects may have answered based on what they were currently experiencing on the computer. Honaker (1988:562) states that if the two forms "do not correlate equally well with relevant external criteria, then it is likely that separate constructs are being measured." No matter how well the researcher tries to control for bias, some bias will always be present. Jaffe and Spirer (1987:134) state, "There is probably no way to eliminate all bias from all questions in all surveys."

Response Bias

Wiseman (1972) found that "responses given in a public opinion polling are not always independent of the method used to collect the data." Response bias is a well-known problem in survey research, which researchers must constantly consider and try to control. Paulhus (1991) defines response bias as a "tendency to respond to a range of questionnaire items on some basis other than the specific item content." Other researchers have referred to response bias with the terms "response set" (Cronbach, 1946:475), "response effects" (Kiesler et al., 1986:404) and "response style" (Dooley, 1995:90).

Response bias may be due to a person's personality, culture, education, desire for social acceptance, or consistent interference from the medium of survey, among many other reasons. Response bias is difficult to determine from surveys or tests unless there is some baseline with which to compare it. Response bias can be accounted for if the means or variances are statistically different between the two methods (Honaker, 1988; Paulhus, 1991).

Cronbach (1946) defines response sets as "any tendency causing a person consistently to give different responses to test items than he would when the same content is presented in a different form." Cronbach (1946) listed six response sets which influence scores: 1) tendency to gamble, 2) definition of judgment categories, 3) inclusiveness, 4) bias; acquiescence, 5) speed versus accuracy, and 6) responses on essay tests. These six response sets are a factor of personal response rather than group response. Cronbach (1946) considers them a bias comparable with constant errors. Their affects can be "reduced by any procedure that increases the structuration of the test situation" (Cronbach, 1946:488).

"Response effects" is another name for response bias. Kiesler et al. (1986:404) defines it as a respondent's:

> Systematically refusing to answer certain questions, or giving incomplete answers or not following instructions, underreporting socially undesirable or threatening information, over reporting socially desirable information, choosing conventional or 'moderate' response categories, and 'yea-saying'—agreeing with whatever the researcher asserts.

Kiesler (1986:406) asserts that computer technology will reduce these effects because the setting will be more impersonal and anonymous, and that respondents "will become self-centered, and relatively unconcerned with social norms and with the impression they give others." In contrast, Reichard (1998) disagrees by arguing that a "Big Brother Syndrome" affects responses because of the focus on security and the ability of computers to track and possibly identify individual users. She suggests people will be more concerned with social norms and the impression they give others because the response becomes a permanent record in a computer system.

One of the earliest attempts to find differences in responses between the two mediums was conducted by Evan & Miller (1969). They constructed a questionnaire based on the popular Minnesota Multiphasic Personality Inventory (MMPI) and administered it by both computer and paper to 60 MIT undergraduate students. They found that subjects answered questions more truthfully under computer administration when the questions were personal or disturbing in nature. However, they found no difference if the questions were impersonal or emotionally neutral, suggesting that the computer was considered an impersonal medium.

A 1990 study by Lautenschlager and Flaherty surveyed 241 psychology students at the University of Georgia using psychological honesty scales of Impression Management (IM) and Self-Deception (SD). They concluded that IM and SD scores were directly influenced by method of administration. Computer users tended to produce lower IM and SD scores, meaning they were not trying to make themselves look better to others or themselves. Similarly, George, Lankford, & Wilson (1992) administered both computer and paper personality surveys to 97 undergraduate student volunteers. Mean differences were found between the paper and computer administration conditions. George et al. summarized that "computer anxiety may artificially inflate negative affect scores during computer administration" (1992:203).

Other studies looking into socially desirable responses (the extent to which one answers a survey to present the most desirable image to another) found differences between the two survey methods, but with unpredictable results. Kiesler and Sproull (1986) presented the Marlowe-Crowne Need for Approval survey to 100 students and faculty members at Carnegie-Mellon University. The found that answers on computers

were less socially desirable and more extreme than answers on paper. In contrast, Schuldberg (1989) reported that subjects who answered surveys by computer administration answered with more social desirability answers and were less open than subjects using paper and pencil. The paper and computer surveys produced different results, but while one study showed more socially desirable answers on paper, the other showed more socially desirable answers on the computer medium.

Although many studies show a link between survey medium and response difference, an equal number indicate no differences (Booth-Kewley et al., 1992; Paulhus, 1991; Lautenschlager et al., 1990; Honaker, 1988). This raises the need to determine what possible methodological differences may have caused researchers to come to such opposite conclusions. Based on this past research and to partially answer research question one (RQ1), the first research hypothesis attempts to find differences, which may indicate bias, in overall means and variances between paper and computer-based surveys:

> **H1a) Overall means and variances will be statistically different between computer-based and paper-based surveys.**

Non-Response Bias

Although not the opposite of response bias, non-response bias is a factor that affects response rate. In short, non-response bias is bias caused by a difference in the attitudes of those who answer a survey and those who do not answer a survey. Non-respondents lower the response rate and may cause an abnormal inflation or deflation of the responses when used to generalize to the population. Non-response bias is caused by people not willing to respond to a survey for any reason in a voluntary setting when their

views may be consistently different from the response group. Singer (1989:50) warns, "non-response can seriously bias survey estimates and distort inferences."

Non-response bias may have to do with a person's preconceived ideas about the survey, questionnaire, or survey medium in general, so the person may not even attempt to complete the survey. Also, the person may attempt or start the survey, but not complete it for some reason. Any reason for not completing a survey is considered non-response bias, and it is present in practically any self-report survey (Kiesler, 1986).

What if the majority of a representative sample is non-respondents, and the minority are respondents? Fowler (1988:48) says, "The effect of non-response on survey estimates depends on the percentage not responding and the extent to which those not responding are biased—that is, systematically different from the whole population." The problem with non-response is not actually in the lack of responses, but is created if those responding are different from the population. Non-response can exacerbate the difference between the sample and population. For example, a survey may have been distributed to a random, representative sample of the population, but if the non-response is high enough, it is unknown if the true views of the population can be assessed by the small potentially biased sub-sample.

There are two forms of non-response bias with equally damaging possible impacts on a study. The first is unwillingness to answer and has to do with a person not responding because the person does not want to. This person has the choice to complete the survey or not, and decides not to complete it for any personal reason. The second form of non-response bias is inability to answer and has to do with someone not being able to fill out a survey for some reason. This may entail the lack of availability or

accessibility of the survey medium. In 1936, the Literary Digest Poll failed because the organizers only polled people with phones. What about people without phones? The same can be said about computers. What about potential respondents without computers? This is probably the most talked about problem in computer survey administration today. Some researchers' sampling frames only contain those individuals who have access to a computer (Rosenfeld et al., 1993). Some polls, found on websites such as CNN.com, can only be accessed by those using a computer with an Internet connection. How generalizable are the results of a poll whose only participants are computer users?

A theory explaining response rates in Air Force members is found in Adams' (1996:25) unpublished study. Her research found that Air Force personnel have higher response rates for paper surveys compared with computer (e-mail) surveys. She theorized that they "perceive written communication as more formal and task-oriented." Because it is perceived as more formal, the response rate for paper surveys is greater than for computer surveys. Conversely, the non-response rate for computer surveys was higher than for paper surveys.

Sjostrom (1999) conducted research to measure non-response error and incorrect answer errors in a survey sent to 4000 Swedish citizens. His calculated response rate was 43% compared with a 62% response rate for another survey conducted similarly to the same population. Sjostrom was able to compare the objective responses to archived historical data to determine whether errors existed in the responses. Because of the relatively low response rate, he concluded that non-response bias accounted for 66% of the error in his survey results when generalized to the population.

To fully answer research question one (RQ1) and to determine if non-response bias is a significant factor between paper and computer surveys, the second research hypothesis attempts to determine equivalency based on response rates:

> **H1b) Overall computer-based survey response rates will be statistically different than paper-based response rates.**

Format Differences

Some research has argued that format differences can affect user responses. Format differences, in this case, refer to surveys with identical questions but different in question order, response type, font (design), or overall complexity rather than differences between the methods of administration. Webster et al. (1996) reasoned that differences discovered between paper and computer surveys, in some studies, could possibly be attributed to the format, design, or complexity differences between two surveys. In other words, researchers may not have controlled for slight format differences making it appear that the any difference was caused by the method of administration rather than format differences. Cizek (1994) found that even the slightest change in answer order in a multiple-choice test significantly affected responses between otherwise identical tests. Moving the correct answer only two positions created unpredictable but "statistically significant differences" (Cizek, 1994:18). He cautioned test creators to avoid reordering options on similar examinations or risk creating unequivocal tests. Beaton and Zwick (1990) suggested that differences between response types (i.e. circling a correct answer versus filling in bubbles for correct answers) affect how respondents answer survey or test items.

Webster et al. (1996:568) states, "Research attention that compares modes of administration while minimizing format differences is needed." Such format and complexity differences are easily implemented on computers (inability to backtrack, increased attention on items when individually presented, immediate and automatic feedback, initial cursor positioning, and survey-taker feelings of no control when previous answers cannot be changed). It does not make sense to compare responses between a paper questionnaire of one design with a computer questionnaire of another design. If the designs are different, how can the researcher tell if any differences are due to the medium or due to the format or complexity differences? When comparing differences in medium of survey or test administration, it is vital to keep format differences minimized (Webster et al., 1996; Comley, 2000; and others). Although researchers have recognized this fact, in many studies (Booth-Kewley et al., 1992; George et al., 1992; Kawasaki et al., 1995; and others), the researchers did not reveal whether format or complexity differences were controlled or not. If differences were controlled, this was important methodological information to exclude.

The following research hypotheses attempt to answer research question two (RQ2) to determine if complexity or format differences introduce significant response bias into survey results:

H2a) Overall means and variances will be statistically different between two computer-based surveys of different complexity.

H2b) Overall survey response rates will be statistically different between two computer-based surveys of different complexity.

Gender and Computers

Why might certain groups display more response bias toward the computer than another group? Gefen and Straub (1997) indicate that a person's gender affects how computers and computer technology is perceived. Although they found no difference in men's and women's use of electronic mail, the study raised questions about perception differences between the sexes that may occur when faced with a computer-based survey as opposed to a paper-based survey.

Venkatesh and Morris (2000:115) asserted that gender differences play a role the "individual adoption and sustained usage of technology." Their study, which focused on gender differences in the linkages of the determinants of technology use and acceptance from Davis' (1989) Technology Acceptance Model rather than mean gender differences in use and acceptance, found that women weighed the determinant "perceived ease of use" (Davis, 1989) as a direct factor of "behavioral intention" (Davis, 1989) more strongly than men. In other words, women's intentions to use technology is influenced by their perception of how easy it is to use that technology to a greater degree than men. An important point that can be reasoned here is that when a man and a woman are both provided an opportunity to take part in a computer-based survey, the woman's willingness to participate in that survey will be more heavily determined by her perceptions of the ease of use of that computer survey than the man.

Which gender might perceive a computer as easier to use? Edwards (1990:107) suggests that men perceive computers as more friendly and familiar than women because men think in the same modes as computers: "syllogistic, quasi-mathematical logic and formal gaming." Edwards (1990:125) also postulates that "computers do not simply

embody masculinity; they are culturally constructed as masculine mental objects." Because men perceive computers as more friendly and familiar than women do, women may be more likely to decide not to participate in a computer-based survey at a higher rate compared with men.

Canada & Brusca (1991), Kramer & Lehman (1990), and Whitley (1996) agree that men have been more socially conditioned to perform well on computers compared with women. Whitley (1996) says "computer use in schools has been linked to traditionally 'masculine' subjects as science and mathematics but not to traditionally 'feminine' subjects such as art and literature." However, his study showed only a small difference between men's and women's anxiety levels and computer-related behavior (Whitley, 1996). Kramer et al. (1990) showed that "gender-related differences in learning and using computers are documented at all educational levels." Canada et al. (1991) concludes from her study that a "technical gender gap" does exist and may cause women to be less likely to meet the technological challenges.

Because women tend to relate to and perceive computer technology different than men, it is believed that women will respond differently to computer and paper-based surveys. It is further believed that because men are more socially conditioned to use and perform well with computer technology, no differences will be found between responses and response rates between the two surveys for men. The following four research hypotheses attempt to answer part of research question three (RQ3) which asks whether gender affects responses between paper and computer-based surveys:

H3a) Women will have statistically different response means and variances between the simple computer, complex computer and paper-based surveys.

H3b) Men will have statistically similar response means and variances between the computer-simple, computer-complex and paper-based surveys.

H3c) Women will have a statistically different response rate between the paper and computer-based surveys.

H3d) Men will have a statistically similar response rate between the paper and computer-based surveys.

Military Commission, Education and Computers

This study looks at differences in individuals of different military commission (officer versus enlisted) because this is an important and obvious distinction among military personnel. How differently might officers and enlisted personnel respond to computer and paper-based surveys? Because no prior research was found that linked military commission to computer use and acceptance, a link can only be drawn from gathered inferential evidence.

The differences between individuals in the officer force and enlisted force are numerous. All officers have a bachelor's degree or higher. According to the Air Force FY2000, first quarter demographic report (AFPC, 2000), only 4.7 percent of enlisted members have a bachelor's degree or higher. The officer force's average age is 35 and the enlisted force's average age is 29 years old. Most officers receive rigorous leadership and command training from basic officer training through intermediary and advanced leadership and command training. Enlisted members receive some leadership training at various stages, but not command training. Lastly, most officers are placed in leadership or command jobs from the beginning of their commission. Enlisted members normally start their enlistment as trainees with few responsibilities and slowly receive more

responsibility as time passes. This difference in responsibility between the two forces places each group into different social classes that can be likened to the working classes of white-collared workers and blue-collar workers.

Which factors might influence how these two groups respond to computer and paper-based surveys? Education appears to be the most distinct difference between the groups, and there is some empirical evidence that suggests that technology and computer use is affected by education level. Even reason seems to suggest that education level affects a person's perceptions about technology and computer use. If computers are used in education, the more educated a person, the less anxiety and more familiarity he or she should have compared to someone who did not spend that time around computers. Even without much computer use in education, education and increased knowledge alone seem to enable a person to be more accepting of innovations and technology (Rogers, 1995). Rogers (1995) says that formal educational background has a significant effect on IT use and acceptance. Rogers states that the more years of formal education a person has, the sooner he or she will adopt IT innovations.

The other major factor that may influence differences in officer and enlisted responses is social structure or class. Because the officer and enlisted forces have traditionally been separated into their own separate social class based on income, occupation, education, and responsibility (Cotton, 1994), it is important to consider these differences beyond simple educational differences. Cotton (1994:409) says that social class should a part of the "normal inventory of independent and mediating variables used by organizational behavior researchers and theorists. Possible relationships have been identified that can occupy the attention of a number of researchers." The present point is

to show that social class (officer versus enlisted) is an important consideration in studying differences within the Air Force. Rogers (1995:269) validates this importance by stating that those with "higher social status" and a "greater degree of upward mobility" will adopt new technologies, like web-based interfaces, much more quickly than those without a high social status of large degree of upward mobility. Other characteristics of people that accept and adopt IT more quickly and easily are those with:

- greater rationality
- greater intelligence
- more favorable attitude toward change
- greater ability to cope with uncertainty
- higher aspirations
- greater knowledge of innovations
- higher degree of leadership (Rogers, 1995:273)

These characteristics are not the separating factors between members of the officer and enlisted force. However, they do give an idea of the type of attributes a person might possess who is more accepting of IT. These characteristics tend to be those of leaders, and officers are the leaders within the Air Force. Because of these factors listed and the general differences that can be roughly assumed between officers and enlisted personnel, it is believed that enlisted personnel will respond differently to computer and paper-based surveys. It is further believed that because officers do have educations that are more formal and are in higher leadership positions than the enlisted force, no differences will be found between responses and response rates between the two surveys for officers. The following four research hypotheses attempt to answer the last

part of research question three (RQ3) which asks whether military commission affects responses between paper and computer-based surveys:

H4a) Enlisted personnel will have statistically different response means and variances between the simple computer, complex computer and paper-based surveys.

H4b) Officers will have statistically similar response means and variances between the simple computer, complex computer and paper-based surveys.

H4c) Enlisted personnel will have a statistically different response rate between the paper and computer-based surveys.

H4d) Officers will have a statistically similar response rate between the paper and computer-based surveys.

Summary

Based on this review of the relevant literature, several conclusions were drawn which helped shape the design and objectives of the current study. Most importantly, whether the survey is psychological or organizational in nature, research findings have been mixed. Some findings of nonequivalence between the two methods of administration found the computer to increase some response bias, while other studies found the computer to decrease some response bias. This further muddles the question of what effect the computer actually plays in the introduction of response bias.

Secondly, most of the research done has been conducted in a controlled environment. Subjects were given some type of stimuli (i.e. computer training program) and then asked to fill out a questionnaire about the stimuli. Other surveys, mostly of a psychological nature, were conducted under experiment like conditions. Only a couple researchers, in the review, allowed the subjects to fill out paper and computer surveys anonymously and without pressure.

A third conclusion concerns the lack of non-response factors found in the previous research. This is important because non-response is a potentially bias introducing factor in most organizational surveys today. Without specifically considering the non-response bias in a study on survey method equivalence, it is impossible to tell whether a paper format and computer format are indeed equivalent on nonequivalent.

Fourth, format and complexity differences (e.g. font, colors, spacing, questions per page, error checking mechanisms) were largely ignored in most studies. Only Webster et al. (1996) focused on format differences as a possible factor in non-equivalency findings.

Lastly, no studies focused on either gender or military commission/education level differences. Any differences that occur between these groups may potentially skew findings, if the differences are not recognized. For example, Booth-Kewely et al. (1992) only tested men Navy recruits finding no differences, but other researchers who studied a mix of men and women found differences. Without specifically considering group biases it is impossible to make accurate findings.

III. Methodology

Chapter Overview

This chapter explains the methodology that was used to answer the research questions and test the research hypotheses presented in the previous two chapters. Based on the literature review of chapter two, this study made every effort to design and conduct an experiment that used the best thoughts from previous research, while avoiding several pitfalls that befell the previous studies. This chapter explains the theory, experimental design, research methods, survey development, population and sample, survey administration, and analytical methods used to test the hypotheses.

Experimental Design

This research design attempts to learn about Air Force members' responses and response rates of surveys using a survey. The survey, in this case, becomes the experimental manipulation, while the observation becomes the analysis of responses and response rates. Using a voluntary survey appears to be the most appropriate way to assess possible bias based on the media of the survey, rather than through some other experimental or observational technique. A key assumption is that people will complete a survey they "like" and not complete a survey they "don't like."

Based on Dooley (1995), this experimental design is composed of a three-factor true experiment using cross-sectional surveys (Figure 1). The experimental design involved sending one of three differing surveys to 900 random active-duty Air Force personnel composed of a 50/50 men/women mix and a 50/50 officer/enlisted mix. Each survey was composed of identical questions and was provided to 300 respondents

through a similar method. Three surveys for 300 people were decided upon based on time and resource limitations and the expectation of a 25-35% response rate. This was hoped to produce a high enough sample size ($N = 90$ for each survey and $N = 45$ for each demographic stratification), which was sufficient to meet the criteria for a statistically large sample (McClave, 1998).

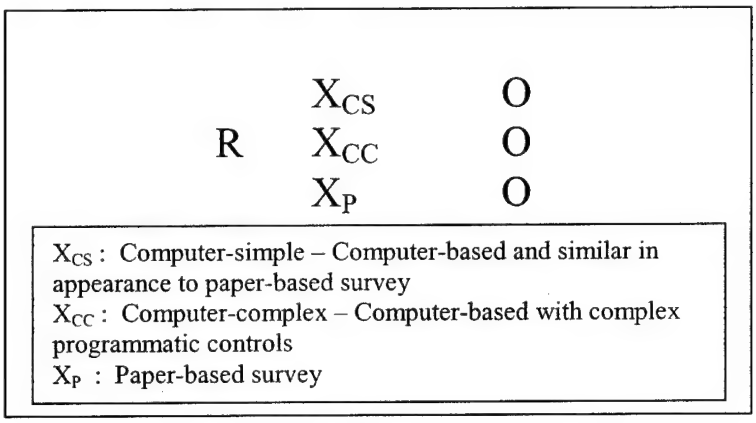

Figure 1. Experimental Design.

Referring to Figure 1, one of the three groups of questionnaires was given a paper-based (X_P) survey. As the most traditional form of questionnaire, it was administered to the control group. The second survey (X_{CS}) was computer-based, accessed over the Internet via a web browser, simple (cs = computer-simple) and similar in format to the paper-based survey. The third survey (X_{CC}) was also computer-based but was complex in format (cc = computer-complex) and had programmatic controls as opposed to the other computer survey to maximize visual and processing differences while keeping the questions the same.

The experimental objective was to make the first two surveys as identical as possible, only differing in medium of administration. The paper-based survey was an

exact replica of the computer-based version in regard to style, font, color, and spacing. The differences were minimized, to the maximum extent possible, so that any differences observed between the two methods were due strictly to the method of administration. For the third computer-based survey, it was important to maximize the differences between the other two surveys. It was colorful, as opposed to the paper and first survey, which were plain black and white, and displayed different fonts and a different layout. Also, programmatic controls were installed to ensure user input was valid and formatted correctly. Lastly, the overall complexity was increased by directing the respondent through several pages of survey material and only allowing the respondent to proceed when all data was correctly and fully input. The goal was to discover any differences introduced by a complex computer-based format. As explained in the literature review, prior research cited format differences as a reason for dissimilarity encountered in user responses (Webster & Compeau, 1996). The current study examined both simple and complex formats simultaneously to determine if any significant differences in responses, which may indicate bias, existed between differing formats.

Research Method

The research method consisted of the following steps based on the chosen experimental design. The remainder of this chapter will explore each step in depth.

1) develop the survey instruments,
2) obtain permission to conduct the survey from Air Force Survey Branch,
3) select subjects from the population,
4) conduct pilot study,
5) administer surveys,
6) gather survey results, and
7) perform statistical analysis of the final data.

Survey Development

Because this study was primarily concerned with user perceptions of the survey instrument based on the medium of administration, the actual content of the survey instrument was less significant than in most survey research. Each survey, X_P (paper-based), X_{CS} (computer-similar), and X_{CC} (computer-complex) provided exactly the same instructions, demographic sections, and questions. Providing exact content attempted to rule out response differences being contributed to differences in questions.

The demographic section was composed of two main areas, mandatory and optional data entry fields. The mandatory fields were gender, rank, AFSC, Major Command, and education level. The optional fields were marital status, number of dependents, years at residence, home of record and yearly income. The mandatory area was important for delineation among respondents. Although the survey required input of specific rank, the analysis section will only delineate between enlisted and officer. The survey collected as many data as possible, but because of an expected small *N,* it was necessary to stratify the data into bi-variate groups per variable under study. The optional section was designed to determine if sensitivity of question affected self-disclosure between methods of administration.

The second section consisted of 10 Likert-style statements. These were statements about the respondent's views of the Air Force, in terms of organizational commitment, and required each respondent to agree or disagree with the statements. The 10 statements are a subset of Mowday, Steers, & Porter's (1979) Organizational Commitment Questionnaire. The organizational commitment scale had demonstrated satisfactory test-retest reliability (r) = .53 - .75, internal consistency (coefficient α) = .82

- .93, and convergent validity = .63 - .74 (Mowday et al., 1979). The study was designed to avoid any reference to computers or computer technology. Webster and Compeau (1996) concluded that computer-based surveys that ask questions about computers might introduce bias because the respondent pays more attention to the computer.

The computer-based survey consisted of a web page with an address of http://en.afit.af.mil/research2000/surveycs.asp or surveycc.asp depending on whether it was the simple or complex format. The programming language used to create the survey was Active Server Pages 3.0. User responses consisted of typed items and "point-and-click" items. Once the user completed the survey, he or she pressed the "submit" button. When the "submit" button was pressed, all the data on the page was saved to a Microsoft Access 97 database residing on the web server. The user then saw a screen explaining that the data was saved. The programming code ensured that no computer could submit a survey more than once. In addition, the code saved the date, time, and Internet Protocol address to the corresponding record. However, the program did not perform error checking of the data on the computer-based similar format, so blank items were allowed. This ensured consistency with the paper-based questionnaire, which did not have error checking. The computer-based complex did have error and validity checking with "pop-up" indication messages to the respondent. This technology was only available because of the computer medium and had no paper-based equivalent beside human intervention.

Permission to Conduct Survey

The Air Force Survey Branch at the Air Force Personnel Center (HQ AFPC/DPSAS) approves all surveys that are administered to active-duty Air Force personnel without specific commander consent. Once the survey was developed, it was

provided along with justification for the survey to the Air Force Survey Branch. It was approved on 8 May 2000 with an AFPC Survey Control Number of SCN 00-34 with an expiration on 31 December 2000. The SCN granted authority to randomly select and survey Air Force personnel based on the prearranged agreement with the AFPC Survey Branch. Air Force Instruction 36-2601 governs Air Force survey procedures and was followed. Additionally, permission was obtained to use the organizational commitment scales from the author Richard T. Mowday on 17 April 2000.

Population and Sample

The population for this study was all Air Force active-duty personnel from Airman Basic to Colonel. General Officers were excluded as a courtesy to their position and responsibilities. To obtain a random sample of 900 Air Force active-duty personnel (450 men and 450 women, consisting of 450 officers and 450 enlisted), an ATLAS listing was requested from the demographics section at AFPC. AFPC provided a random sample of a 50/50 mix based on gender and rank on 11 May 2000. The listing included name, rank, MAJCOM and duty address.

Pilot Test

A pilot test was conducted to ensure the understandability, usability, and internal reliability of the paper-based and computer-based surveys. This involved administering the three questionnaire types (paper, computer-simple, and computer-complex) to AFIT graduate students in the Information Resource Management program. Results from the pilot test helped refine the final survey instruments, cover sheets, and administration procedures. Most significantly, two questions were reworded based on some comments of confusion from the pilot group, and the cover sheets were reworded to produce a more

pleasing tone. Additionally, some errors occurred on the web pages that required reprogramming and other slight modifications.

Although a Cronbach's alpha measurement of .54 was calculated as the internal reliability of the questions, no questions were subsequently removed. Removing any one question would have lowered the alpha level. It was believed that the low alpha was a result of a relatively low number of participants in the pilot test ($N = 18$) and the high probability of bias as a result.

Survey Administration

Nine hundred number 10 white envelopes were addressed and validated by the United States Postal Service based on the listing from AFPC. Three hundred paper questionnaires were created based on a printout of the survey web page. A cover page accompanied each paper-based questionnaire explaining the reason for the survey, asking for the respondent's cooperation, and providing instructions for returning the survey in the pre-addressed return envelopes within two-weeks. The return postage was free to respondents because the envelopes traveled through official mail channels. The cover letters and surveys were randomly assigned to three hundred number 10 envelopes along with the pre-addressed number 9 return envelopes. The other 600 personnel received one of two other instruction sheets. Both instruction sheets matched the paper-based survey's cover sheet, but directed the user to go to a computer and type the Internet address into the computer's browser within 2 weeks of receipt. The X_{CS} computer-based survey was named "surveycs.asp" while the X_{CC} computer-based survey was named "surveycc.asp." In addition, a final instruction on the cover letter asked the respondent to return the included pre-addressed postage-free 4" by 6" postcard, if he or she did not have

access to a computer. The postcard had space for the respondent to list the required demographic data. If the respondent had a computer, the instructions asked him or her to simply discard the postcard.

Gather Survey Results

Approximately two months were allowed from the first mailing day before analyzing data. The computer-based survey database was checked daily to make sure there were no problems with access or corruption. As computer-based surveys were submitted, an automatic e-mail message was sent to the researcher's AFIT e-mail account so response rate could be continually monitored. Completed paper surveys were collected at the AFIT/ENV organizational box as needed.

All paper survey data were manually updated into Microsoft Excel 2000. Each response sheet was individually coded into a spreadsheet row. The computer-based responses, which were collected through a web-based Microsoft Access 97 database, were imported into the same Microsoft Excel 2000 spreadsheet for analysis.

Analytical Methods (Statistics)

The first analytical test of the data involved comparing response rates. For each method (paper, computer-simple, and computer-complex) the response rate was obtained by dividing the number received by the number sent. The number sent for each method was not 300, since approximately 15-20 of each survey was returned because of personnel moves or insufficient addresses. Next, the assumptions of normality and large sample were verified. Independence was assumed for the proportions since the samples for each survey are unrelated to the other samples. Next, the three population proportions were compared based on meeting these three assumptions. This first test examined

whether the proportion of respondents was statistically equivalent. For this test, and the following tests, a two-tailed hypothesis test with the Type I error rate set at alpha (α) = .10 was used to test for equivalency. Since this research was exploratory in nature, this relatively high alpha level was deemed appropriate based on past exploratory research alpha levels (Arbaugh, 2000; James & Wortring, 1995). First, the paper-based survey was compared to both computer-based surveys. Then the two computer-based surveys were compared together. Microsoft Excel 2000 aided in calculations of the formula shown in Figure 2.

$$H_0 : (\hat{p}_1 - \hat{p}_2) = 0$$
$$H_A : (\hat{p}_1 - \hat{p}_2) \neq 0$$
$$\textit{Test Statistic: } z = \frac{(\hat{p}_1 - \hat{p}_2) - 0}{\sigma_{(\hat{p}_1 - \hat{p}_2)}}$$
$$\textit{RejectionRegion: } z < -z_{\alpha/2} \text{ or } z > z_{\alpha/2}$$

Figure 2. Two-Tailed Test for statistical difference (McClave, 1998).

The results of this test told whether or not the response rates were equivalent. Next, any differences among gender and military commission were tested. These tests were the same as shown in Figure 2. The test determined if a statistical difference between two proportional groups existed once the assumptions of normality, large samples, and independence were verified. The goal was to find a statistically significant difference in response rates across these groups.

After completion of the proportion tests, responses to the Likert-style questions were assessed between the three surveys and between gender and military commission.

The ten organizational commitment scales were added together to provide a composite score for each person. This composite score per person was calculated for each questionnaire using Microsoft Excel 2000. The statistical package JMP Version 3.2.6 was used to calculate the Analysis of Variance (ANOVA) to determine if a statistical difference in the survey answers existed. ANOVA compares the variance of sample data contained within each survey group (treatment group) with the variance across other groups to analyze the null hypothesis regarding the equity of the means for each group. ANOVA was conducted between the three surveys, between men and women, and between officers and enlisted using a 3 X 2 X 2 ANOVA.

The ANOVA was conducted using a series of F-tests to evaluate the effects of each survey on group means. An F-statistic p-value was computed and determined statistically reliable when the probability of a Type I error was less than the set alpha of 10% ($\alpha < 0.10$). If the F-statistic p-value was found to be larger than the error level, the null hypothesis was rejected in support of the alternative hypothesis that a significant difference between means was found. Any significantly different findings of this kind pointed to possible response bias based on survey administration method.

Summary

This chapter explained the research design and methodology used to compare the responses and response rates between 900 surveys randomly administered to Air Force active-duty personnel. The research goal was to determine if there was any statistical difference between the responses or response rate, and if that difference could be contributed to bias based on the medium of survey administration. Gender and military commission were used to determine if any differences were more or less likely for groups

based on these variables. The results of all the analysis and tests will then be used to draw conclusions about the impact of the computer medium on survey administration in the Air Force.

IV. Results and Analysis

Chapter Overview

This chapter presents the analysis and findings of the survey response data and response rates. First, a review of the internal reliability results of the questionnaire will be presented. Next, data analysis will focus on answering each the three research questions and associated hypothesis statements proposed in the previous chapters. This analysis will concentrate on response rates and survey scores overall, by gender, and by military commission. On completion of this chapter, each research question will be fully answered.

Questionnaire Reliability

Because of the low .54 internal reliability level discovered during the pilot test, it was essential to calculate the Cronbach alpha for the final data to verify its high reliability. As anticipated, the Cronbach alpha level was much higher with a calculated $\alpha = .89$. This reliability level passed and exceeded Straub's (1989:160) ".80 rule-of-thumb" for a reliable measurement. In addition, it validated Mowday's own internal consistency measurement of $\alpha = .82 - .93$ for the Organizational Commitment Questionnaire (OCQ) (Mowday, et al., 1979). Thus, the small alterations to the original OCQ to adapt it to Air Force personnel did not change its reliability in this study.

Questionnaire Results

The survey consisted of ten statements to which respondents agreed or disagreed according to a 5-point Likert-scale. Although the actual responses (commitment level score) of the respondents did not matter to the objectives of this study, the scores were

used to determine differences in responses across the three different mediums. As a quick overview of respondent participation, the following table helps summarize the response rates and demographics of response data collected. Detailed data analysis, categorized by individual question, is provided in Appendix B.

Table 1. General Demographics and Response Rates.

	Paper	Computer Simple	Computer Complex	Total
Overall	50.53% *N = 143*	44.37% *N = 126*	45.49% *N = 116*	46.84% *N = 385*
Men	47.52% *N = 67*	37.32% *N = 53*	45.07% *N = 64*	43.29% *N = 184*
Women	53.52% *N = 76*	51.41% *N = 73*	46.02% *N = 52*	50.63% *N = 201*
Officer	60.69% *N = 88*	46.81% *N = 66*	48.23% *N = 68*	51.99% *N = 222*
Enlisted	39.86% *N = 55*	41.96% *N = 60*	42.11% *N = 48*	41.27% *N = 163*

To answer each research question, tests for both response rates and actual responses were conducted. The response rates were calculated by taking the number of surveys sent, subtracting the number returned (for such reasons as permanent change of station, wrong address, retirement, etc.) and dividing this number into the number received back from the respondent. For survey response analysis, the responses to each question for each person were combined into a composite score of commitment level. Three questions, one, six and ten, were reverse coded to aid in reliability and were switched to the corresponding value (1 to 5, 2 to 4, etc.) before being added to the composite score. Each respondent's composite score could range from a minimum of 10 (very low commitment level) to a maximum of 50 (very high commitment level). These scores were calculated for each survey type and analyzed using ANOVA tests to

determine if one or more surveys produced statistically significant results at a .10 alpha level.

Research Question 1 Analysis

The first research question (RQ1) asked: Are computer-based and paper-based survey instruments equivalent? Two hypothesis statements were used to test this question. The first research hypothesis (H1a) proposed that overall means and variances would be statistically different between computer-based and paper-based surveys. This hypothesis was based on research that indicated that the computer medium might affect survey responses.

Table 2 shows the test results for hypothesis H1a with the test *($F(1, 377)=0.1107$, $p = 0.74$)*. In order to reject the null hypothesis, the p-value would have to be less than 0.10, meaning that one of the surveys had a score significantly different from the other survey. Since the p-value was greater than 0.10, the null hypothesis was not rejected. In addition, the Welch ANOVA p-value was 0.74. Because this value was also greater than 0.10, the evidence for not rejecting the null hypothesis was strengthened. To ensure that constant variance and normality had not been violated, the Levene p-value was shown to be greater than 0.10. To summarize the findings for hypothesis H1a, there is insufficient evidence to conclude any difference between means and variances of the paper and computer surveys.

Table 2. Test Result Hypothesis H1a, Research Question One.

H_0: Mean and Variance Differences = 0			
	N	Composite Score Mean	Standard Deviation
Paper	140	38.107	8.1502
Computer Combined	239	38.385	7.6637
ANOVA	*F(1,377)=0.1107, p=0.74*		
Welch ANOVA	*F(1,276.89)=0.1071, p=0.74, t=0.33*		
Levene	*F(1,377)=0.8156, p=0.67*		

The second research hypothesis (H1b) proposed that overall computer-based survey response rates would be statistically different from paper-based response rates. The test required a comparison of response rates for the paper survey with the combined response rate of both the computer-simple survey and computer-complex survey. Both computer survey response rates were combined since the comparison was between paper and computer regardless of the computer survey type. If it was found that the response rates were significantly different between the paper and computer versions of the survey, the two versions may not be considered equivalent instruments.

Table 3 presents the test results for hypothesis H1b. The test statistic calculated by the inference concerning two proportions was 1.537. In order to reject the null hypothesis, the test statistic would have to be greater than the calculated Z-score ($Z_{10/2}$) of 1.645. Since the test statistic did not lie in the rejection region, there was insufficient evidence to reject the null hypothesis. In other words, the evidence did not indicate a significant difference in response rates between computer and paper surveys. However, it is important to note that at higher Z-scores (greater than $Z_{12/2}$) the difference would be considered statistically significant. Consequently, while the standards adopted for the

current hypothesis test show the difference to be statistically insignificant, standards that are more liberal would have found significant differences between the two methods of administration based on response rates.

Table 3. Test Result Hypothesis H1b, Research Question One.

H_0: Response Rate Differences = 0				
	N	Response Rate	Rejection Region	Test Statistic
Paper	143*	.5053	Z > 1.645	Z = 1.537
Computer Combined	242*	.4489		
* indicates different *N* from ANOVA tests since 6 responses were thrown out because of missing or incomplete data for the ANOVA test.				

While both research hypotheses, H1a and H1b, failed to show significant overall evidence that paper and computer mediums elicited different responses from all the Air Force respondents, patterns were found in the data that showed there might be slight effects. For instance, six of the seven hypothesis tests to find differences in response rates found that the paper survey, on average, received a consistent 5-10% greater response rate than the computer survey. This significant finding was hidden by the actual hypothesis tests. In other words, the paper-survey consistently received a higher response rate, and this fact deserves attention.

This consistent 5-10% difference in response rates is remarkable. Several reasons can be provided to try to explain the difference. First, one conclusion is that Air Force members felt more comfortable filling out a paper survey versus a computer survey. One former Air Force Institute of Technology student (Adams, 1996) concluded in her unpublished thesis that Air Force members are more comfortable with written

correspondence as compared with e-mail correspondence because the paper medium is viewed as more formal. Another conclusion that can be drawn from the consistent 5-10% greater response rate for paper surveys is that respondents were less comfortable with the computer medium rather than more comfortable with the paper medium. The only way to know which viewpoint is more accurate is to have a standard with which to compare the response rates. Unfortunately, there is no standard, and studies (Sjostrom, 1999) have reported response rates for the same population to be 43% to 62% after a short time. This indicates that one population may not have a standard expected response rate from which to compare future response rates.

Based on the results of these two hypothesis tests, the evidence suggests that there is no significant difference between the paper and computer surveys and they can be considered equivalent instruments. However, before making this conclusion, it is important to weigh this result with the results of the next two research questions. These research questions look at groups within the respondents. If one or more groups show differences that are not significant enough to affect the overall tests, the surveys may be found to be nonequivalent instruments in that circumstance.

Research Question 2 Analysis

The second research question (RQ2) asked: Do complex computer-based surveys introduce significant bias into survey responses? Two hypothesis statements were used to test this question. The first research hypothesis (H2a) proposed that overall means and variances would be statistically different between the two computer-based surveys. This hypothesis was based on research that showed that even slight format changes might affect user responses indicating bias.

Table 4 presents the test results for hypothesis H2a with the test *(F(1, 238)=2.3447, p = 0.13)*. In order to reject the null hypothesis, the p-value would have to be less than 0.10, meaning that one of the surveys had scores significantly different from the other survey. Since the p-value was greater than 0.10, the null hypothesis was not rejected. In addition, the Welch ANOVA p-value was 0.13. Because this value was also greater than 0.10, the evidence for not rejecting the null hypothesis was strengthened. To ensure that constant variance and normality had not been violated, the Levene p-value was shown to be greater than 0.10. To summarize research hypothesis H2a, there was insufficient evidence to conclude any difference between means and variances between the simple and complex computer survey types.

Table 4. Test Result Hypothesis H2a, Research Question Two.

H_o: Mean and Variance Differences = 0			
	N	**Composite Score Mean**	**Standard Deviation**
Computer Simple	123	39.163	8.0565
Computer-complex	117	37.649	7.2007
ANOVA	*F(1,238)=2.3447, p = 0.13*		
Welch ANOVA	*F(1,237.09)=0.2.358, p=0.13, t=1.536*		
Levene	*F(1,238)=1.4671, p=0.23*		

The next research hypothesis (H2b) proposed that overall survey response rates would be statistically different between simple and complex computer-based surveys. The test required comparing response rates for the paper survey with the combined response rate of both the computer-simple survey and computer-complex survey. If it was found that the response rates were significantly different between the two computer

versions of the survey, the two versions may not be considered equivalent instruments and effects of possible bias would have to be considered.

Table 5 presents the test results for hypothesis H2b. The test statistic calculated for the inference concerning two proportions was 0.2619. In order to reject the null hypothesis, the test statistic would have to be greater than the calculated Z-score ($Z_{.10/2}$) of 1.645. Since the test statistic did not lie in the rejection region, there was insufficient evidence to reject the null hypothesis. In other words, the evidence did not indicate a significant difference in response rates between complex and simple computer surveys.

Table 5. Test Result Hypothesis H2b, Research Question Two.

H_0: Response Rate Differences = 0				
	N	**Response Rate**	**Rejection Region**	**Test Statistic**
Computer-simple	126*	.4437	Z > 1.645	Z = 0.2619
Computer-complex	116	.4549		
* indicates different *N* from ANOVA tests since 3 responses were thrown out because of missing or incomplete data for the ANOVA test.				

From these two hypothesis tests, the evidence indicates that there is no difference between simple and complex computer surveys, and they can be considered equivalent instruments. Consequently, it can be reasonably concluded that significant bias was not introduced by the computer survey complexity. However, as stated for research question one, further analysis of groups stratified by gender and military commission should be considered before eliminating all uncertainty.

Research Question 3 Analysis

The third research question (RQ3) asked: Are computer-based and paper-based survey responses or response rates affected by a person's gender or military commission? Two groups of four research hypotheses were used to test this question. The first group of hypotheses focused on response means and variances for men, women, officers and enlisted personnel. The second group of hypotheses focused on response rates for men, women, officers and enlisted personnel. To determine statistically significant differences in response means between men, women, officer, and enlisted personnel across the three survey types, a whole model ANOVA test was developed and run using a 2 X 2 X 3 factorial design. This test yielded the results *($F(11, 367) = 1.5515, p = .11$)*. Because the p-value was not less than the .10 significance threshold, this indicated that no effect was statistically significant. In other words, no mean differences were found among men, women, officers, and enlisted personnel across the three survey types.

Hypothesis H3a proposed that women would have statistically different response means and variances between the three survey types. The null hypothesis, which stated that there was no difference, was not rejected in this case. Similarly, hypothesis H4a, which proposed that enlisted personnel would have statistically different response means and variances between the three survey types could not be established. The null hypothesis for this test was also not rejected.

Both hypotheses H3b and H4b stated that men and officers would have statistically similar response means and variances between the three survey types. The null hypothesis for both tests were not rejected meaning that, as expected, men and officers had statistically similar response means and variances across the three survey

types. Because of this expected result, a power analysis was conducted to determine the likelihood of a Type II error. The power was calculated to be .85 - .93 for men and .95 - .97 for officers. These high power numbers are based on the ability to detect a statistically significant 4-point spread in the means within groups. Additionally, this high power indicates that the likelihood of having committed a Type II error is low.

The last four research hypotheses were examined using proportional tests of response rates. Hypothesis H3c proposed that combined computer-based survey response rates would be statistically different from paper-based response rates for women. Hypothesis H3d proposed that the response rates would be similar for men. Hypothesis H4c proposed that combined computer-based survey response rates would be statistically different from paper-based response rates for enlisted personnel. Lastly, hypothesis H4d proposed that the response rates would be similar for officers.

Each test required comparing response rates for the paper survey with the combined response rate of both the computer-simple survey and computer-complex survey. If it was found that the response rates were significantly different between paper and computer versions of the survey, the two versions may not be considered equivalent instruments.

Table 6 presents the test results for hypotheses H3c, H3d, H4c, and H4d, since they were almost identical tests. The test statistic calculated for the inference concerning two proportions was 0.8599 for women, 1.2382 for men, -0.4173 for enlisted personnel, and 2.5799 for officers. In order to reject the null hypothesis, the test statistic would have to be greater than the calculated Z-score ($Z_{10/2}$) of 1.645. Since the first three test statistics were not in the rejection region, there was insufficient evidence to reject the null

hypothesis. In other words, the evidence did not indicate a significant difference in response rates between computer and paper surveys for men, women, or enlisted personnel. However, the test statistic for officers was 2.5799, which was greater than the Z value of 1.645. Here the null hypothesis was rejected because the evidence indicated there was a statistically significant difference between the way officers answered the paper survey compared with the computer-based surveys.

Table 6. Test Result Hypothesis H3c/H3d/H4c/H4d, Research Question Three.

Women H_0: Response Rate Differences = 0				
	N	**Response Rate**	**Rejection Region**	**Test Statistic**
Paper	76	.5352	Z > 1.645	Z = 0.8599
Computer Combined	125	.4902		
Men H_0: Response Rate Differences = 0				
	N	**Response Rate**	**Rejection Region**	**Test Statistic**
Paper	67	.4752	Z > 1.645	Z = 1.2382
Computer Combined	117	.4120		
Enlisted H_0: Response Rate Differences = 0				
	N	**Response Rate**	**Rejection Region**	**Test Statistic**
Paper	55	.3986	Z > 1.645	Z = -0.4173
Computer Combined	108	.4202		
Officers H_0: Response Rate Differences = 0				
	N	**Response Rate**	**Rejection Region**	**Test Statistic**
Paper	88	.6069	Z > 1.645	*Z = 2.5799
Computer Combined	134	.4752		
* Significance				

Summary

This chapter presented results and statistical analysis performed on data collected through the survey instrument administration. The summarization of the results of this analysis is presented in Table 7, below. Chapter V discusses these results and provides conclusions as to what these results mean for practitioners and academia of survey research.

Table 7. Hypotheses Results.

NO.	STATED HYPOTHESIS	RESULTS
H1a	Overall means and variances will be statistically different between computer-based and paper-based surveys.	Not Supported
H1b	Overall computer-based survey response rates will be statistically different than paper-based response rates.	Not Supported
H2a	Overall means and variances will be statistically different between two computer-based surveys of different complexity.	Not Supported
H2b	Overall survey response rates will be statistically different between two computer-based surveys of different complexity.	Not Supported
H3a	Women will have statistically different response means and variances between the simple computer, complex computer and paper-based surveys.	Not Supported
H3b	Men will have statistically similar response means and variances between the computer-simple, computer-complex and paper-based surveys.	Supported
H3c	Women will have a statistically different response rate between the paper and computer-based surveys.	Not Supported
H3d	Men will have a statistically similar response rate between the paper and computer-based surveys.	Supported
H4a	Enlisted personnel will have statistically different response means and variances between the simple computer, complex computer and paper-based surveys.	Not Supported
H4b	Officers will have statistically similar response means and variances between the simple computer, complex computer and paper-based surveys.	Supported
H4c	Enlisted personnel will have a statistically different response rate between the paper and computer-based surveys.	Not Supported
H4d	Officers will have a statistically similar response rate between the paper and computer-based surveys.	Not Supported

V. Conclusions and Recommendations

Chapter Overview

The primary objective of this study was to determine whether computer-based surveys could be considered equivalent to analogous paper-based surveys in a voluntary, self-report environment. Additionally, two secondary objectives were studied. The first was to determine if format and complexity differences among computer-based surveys introduce significant additional bias into survey response rates and actual responses. The second was to determine if different survey administration methods influenced the response rates and responses of various groups. The three research questions below were developed to investigate these objectives.

> ***Research Question 1.*** *Are computer-based and paper-based survey instruments equivalent?*
>
> ***Research Question 2.*** *Do complex computer-based surveys introduce significant bias into survey responses?*
>
> ***Research Question 3.*** *Are computer-based and paper-based survey responses or response rates affected by a person's gender or military commission?*

During this final chapter, each of these questions will be answered in relation to their associated hypotheses results and other pertinent information gathered while analyzing the respondents' data as a whole. Following the answers to and discussion of each of these research questions, this study's limitations will be discussed. Finally, suggestions for future research, which are based on additional questions this study evoked, will be presented.

Research Question 1

Research question one asked if computer-based and paper-based survey instruments could be considered equivalent. This was the fundamental question of this study. As explained in the literature review, equivalency in this study focused on the rules of equivalency as provided under Classical Test Theory presented in chapter 2. In short, this theory says that two surveys can be considered equivalent if they produce statistically equal mean scores. Based on the results of the two hypotheses used to test this question and the results of the subsequent tests, it was determined that similar surveys administered via paper and computer can be considered equivalent.

Research Question 1 Discussion

The results of this question indicate that, in general, a valid and reliable paper survey can be translated into a computer survey without changing the validity or reliability of the survey. However, there is a major caveat. This provision only applies to surveys of non-sensitive question content, as provided in the current study's survey. Surveys of a sensitive nature may or may not be validly or reliably translated to a computer format because of the respondent's greater need to possibly hide true information or provide false information as demonstrated in other key studies using sensitive questions (Honaker, 1988; Lautenschlager et al., 1990). In addition, surveys that cause the respondent to focus on the survey instrument specifically (e.g. computer survey about computers) may introduce validity problems because the salience of the computer may change the construct under study (Webster et al., 1996). However, a survey of organizational or work related content should be reasonably expected to provide valid and reliable results as this study revealed.

This study revealed some interesting trends in organizational survey administration that deserve some attention. As noted in the previous chapter, paper response rate was consistently higher, around 5-10%, for all groups except one, enlisted personnel. Although the difference did not prove to be statistically significant, the difference appears to be a tendency that survey managers should consider in survey design. It appears that a paper-and-pencil survey will receive a marginally higher response rate compared to a similar computer-based survey but not with all groups. This may be important if a manager's goal is to maximize participation in an organizational survey.

The only group that did not have a higher paper response rate, enlisted personnel, had the lowest response rates of each survey type. Although not a focus of this survey in terms of initial objectives, it is interesting that this group had an average paper response rate of 40% while officers had an average paper response rate of 61%. Could this difference have been caused by the survey content? Could this be a result of a greater sense of duty by officers? Since the survey was being conducted by an officer, could that have caused fellow officers to participate out of a sense of kinship? Data are not available to answer these questions, but managers must be aware that some groups may not want to answer surveys as readily as other groups whether the medium is paper or the computer.

Research Question 2

Research question two asked if computer-based surveys of different format and/or complexity levels introduce significant bias into survey results. Webster et al. (1996) suggested that this issue needed further investigation. She felt that there had been so

many contradictory findings, when comparing paper to computer surveys, that it was possible that format differences were causing this contradiction. Both Cizek (1994) and Zwick (1990) found that slight differences in survey format and/or question order could affect user responses. Based on the two hypotheses used to test this question, it can be determined that complexity and format difference had no significant effect on user responses. Therefore, it is unlikely that significant bias could be introduced into results based on complexity or format differences under similar circumstances.

Research Question 2 Discussion

The finding that complexity and format differences had insignificant effects on non-response and mean score responses was not surprising, although this study hypothesized the opposite effect. It was important to provide both a simple computer survey and a complex computer survey in one study to enable any affects to be studied at one time under uniform circumstances. Prior research, as indicated, was very concerned about small modifications changing the reliability and even validity of computer surveys. This was even a suggested as a cause for different conclusions being drawn from different studies concerning equivalence of paper and computer tests and surveys (Webster et al., 1996).

Over the past several decades of computer-based testing and polling, computer interfaces have become easier to operate. Computer applications are becoming increasingly intuitive, as programs have evolved from command line interpreters to Windows based graphical user interfaces. Widespread use of touch screen and voice activated interfaces are the next evolution in computer testing, polling, and surveying. This is important to note because any computer survey or testing equivalency research

greater than five to ten years prior to the present day was done using interfaces that were more difficult to use. Prior research that indicated differences between computer-based surveys or testing could be due more to the interface presented than the computer technology available. In the past, a respondent may have been required to physically type responses to Likert-style questions or press strange key combinations to perform given commands. It would be expected that format and complexity differences several years ago, would be more of a factor than format and complexity changes today. Therefore, past research that showed that format differences affected user responses was probably a greater source of error than in today's web-based environments. Web-based innovations tend to help the user (with programmed meaningful error messages) rather than confuse or dissuade a user of some archaic DOS-based program. In other words, the findings of this study may indicate that complexity and format differences may not be as significant between surveys on the same medium as the differences once were.

Practitioners and academics can be reasonably assured that a validated and reliable paper-based survey can be translated into a computer web-based format without having to make the computer-based survey look exactly like the paper-based version. Furthermore, it is advantageous to use the computer environment to more efficiently lead a respondent through a complex survey. For example, some paper-based surveys tell the respondent to skip section X if the answer to the following question is Z. In addition, some questions may say to disregard the question if the respondent is a male. With a computer-based survey, the respondent will only be provided the information he or she needs based on previous inputs. Furthermore, data can be error-checked for accuracy,

real-time, and provide easy to understand messages that require the respondent to fix any erroneous inputs.

For researchers, a computer-based environment allows correct, valid, and error free data to be saved and tabulated as it is received. Statistical results can be automatically adjusted with each respondent with no additional monitoring by the researcher. The more complex the survey, the more the researcher can and should rely upon the programming of the survey to take care of the collection and validation of data.

Research Question 3

This complex question asked whether a person's gender or military commission affects the response he or she (officer or enlisted) has towards computer-based and paper-based surveys. As gender studies indicated in the literature review, men and women have different relationships with information technology. For this study, it was unknown whether this relationship (more comfortable for men and less comfortable for women) would introduce bias, which could be detected in response rates and composite scores. It was also unknown whether bias would be in the form of higher response rates for paper surveys or computer surveys or higher composite scores for either gender.

As the discussion also indicated in the literature review, those with higher education tended to adopt and accept innovations and information technology much more readily than those with less education (Rogers, 1995). Just as with gender, it was unknown whether this relationship, theoretically closer for officers whom all have college degrees as opposed to enlisted members of whom 4.7% have degrees, would introduce bias, which could be detected in response rates and composite scores. And like gender, it was also unknown whether bias would be in the form of higher response rates for paper

surveys or computer surveys or higher composite scores for either officers or enlisted personnel. Based on the eight hypotheses (H3a, H3b, H3c, H3d, H4a, H4b, H4c, H4d) that were used to test this question, it can be reasonably determined that military commission and gender do not cause significant bias to be introduced into differing survey mediums under administration methods similar to the ones in this study. However, officers tended to return paper-based surveys at a statistically significant higher rate than computer-based surveys. All other groups (males, females, and enlisted personnel) had statistically similar response rates across the various surveys. Even with this one unusual finding, practitioners of surveys for the military community can be reasonably assured that survey complexity or format differences among similar surveys will not affect responses, although response rate may be affected.

Research Question 3 Discussion

A surprising aspect about this question is that military commission seemed to factor into the response rate oppositely than hypothesized based on the characteristics listed by Rogers (1995). Rogers (1995) provided a strong case that individuals who had a high degree of leadership, higher aspirations, and a greater ability to cope with uncertainty were more favorable to adopt innovations such as computer-based testing or surveys. This seemed to indicate that individuals with these characteristics, namely officers, would have been equally comfortable with the computer and paper medium. What the findings showed was that officers tended to respond less favorably to the computer medium, whereas enlisted personnel responded equally favorably between the computer and paper mediums. What impact does this have on survey practitioners and academia?

The impact of this finding on survey research depends on the impact in relation to survey reliability or validity. If the paper medium is assumed the baseline for survey research, the question then becomes how does a lowered response rate for one group of a sample (conversely higher non-response rate) affect computer survey reliability or validity? Compared with the paper response rate in this study, the non-response rate was different between the two mediums by 13.2%. Another way to view this is that 13.2% less officers in the sample responded to the computer survey compared with the paper survey. If the opinions and beliefs of that 13.2% differed significantly from the rest of the respondents, then bias may have been a factor to cause worry. For this study, however, it is known how that 13.2% responded (mean scores) to the paper survey. They responded statistically similarly as the rest of the sample because no difference was found in mean scores between the two groups. Thus, it is safe to assume, in this case, that the higher non-response for the computer-based survey was not indicative of the introduction of bias. It can also be assumed that reliability and validity could not have been affected either.

Another point that the answer to this question makes is that academia's notions of the impact of technology adoption on survey response should be examined. It was the notion of this study that greater comfort with computers meant an anticipated greater use of computers. Conversely, the findings showed that an assumed high comfort with computers did not correlate with a greater use of computers. In fact, the opposite occurred. Responses to computer surveys were the same or less than that of the paper survey regardless of gender or military commission. The data actually indicate that the paper medium was regarded higher than the computer medium across the sample,

although not at a statistically significant level except for the case of officers. This corresponds to Adams' (1996) unpublished thesis findings that written communication was seen as more formal and task-oriented than the computer format and that military members had a higher response rate with written media. Practitioners and academia cannot assume that a group that has a high acceptance level with computer technology will necessarily use the computer to a greater degree compared with paper within a survey. However, this is not to say that a greater acceptance level with other computer applications will not lead to greater use of that application outside the context of surveys.

In summary, the evidence supports that military commission has a slight effect on response rate in a survey but does not affect response means or variances in a survey. Most interestingly, the data and analysis indicate that military members will respond better to a paper survey than a computer survey whether they are officers, enlisted personnel, men, or women, although response means and variances are not affected. Lastly, academia and practitioners of surveys cannot assume that a greater acceptance of computer technology by a respondent will result in a greater use of computer technology by the respondent.

Limitations

It is important to recognize several potential limitations in this study. A key limitation was the use of the United States Postal Service and DoD Official Mail service provided by each base. Delivery of the survey package was contingent upon a good address and proper handling by these two agencies. Getting the mail responses back relied just as heavily on a flawless postal and base postal system. To test the strength of this system, the author picked one surveyed group and called each non-respondent in that

group. The author found that approximately one-third of the personnel 1) never received the survey through official mail 2) moved to another base or 3) were on temporary duty at another location. Because all the surveys were sent to a random sample, the author believes these problems were uniform across all groups. However, it is reasonable to assume that these problems may have affected the results in some unknown way.

A second limitation was the absence of a retest. A retest could have confirmed the validity of the results from the first test. The study could have benefited by testing how response groups differed over time, or even how different groups responded to survey mediums they had not previously been given. However, time limitations for this study precluded a test-retest reliability survey.

Another limitation was the assumption that officers and men were comfortable with computer technology and women and enlisted personnel are not as comfortable with computer technology. Although cites in the literature review generally supported these generalizations, the reality of these generalizations are not very supportive. Many women and enlisted personnel are computer experts and more comfortable with computer technology than other men or officers in the Air Force. The generalizations drawn are not absolute and may be incorrect in many ways. The survey should have asked for a level of computer experience or comfort level with computers to better categorize those respondents who were or were not comfortable with computer technology. As they stand, the generalizations that formed the hypothesis statements can be considered weak at best.

A final limitation concerns the complexity level designed into the complex computer based survey. The complexity level was very subjective because no empirical

data existed to suggest what made a survey simple or complex. It was made complex based on what the author thought complexity entailed. Conclusions that were drawn based on differences between the simple and complex survey are difficult to quantify because what is complex for one person may not be complex for another person. An additional post survey to determine a level of complexity from the respondent's view would have been beneficial to make sure a complexity difference actually existed between the two computer surveys.

Future Research

This study, perhaps, generated many more questions than it satisfactorily answered. Several key questions, indicating areas of future research, would be beneficial to answer for research groups such as the Air Force Survey Branch. First, why did officers answer the paper survey with such a high response rate compared to any other group? It would be of interest to verify that this is the case, and if so, why? This could have implications into the best way to elicit high response rates from different groups.

Second, what would be the effects of sensitive questions between paper and computer surveys? Previous research shows that the biggest differences in responses normally occurred when questions were of a sensitive nature. It would be useful to quantify this effect for the Air Force population.

Third, if given the choice to take either a paper or a computer survey, which survey would Air Force personnel take? In this study, each group was sent a specific survey and asked to take it. If survey medium is a choice of a respondent, this may help quantify respondent preference. Based on this research, it appears that certain groups, such as officers, preferred the paper medium, whereas male enlisted personnel preferred

the computer medium. Quantifying these differences and why these differences occur would certainly add to this growing body of knowledge.

Lastly, what is the relationship between a person's likelihood to adopt a new technology and his or her likelihood to actually use that new technology compared with the older technology. This study found a conflict between past research and actual results in the study. Past research indicated that the more educated a person is the sooner he or she will adopt the technology. In practice, this research seemed to indicate that regardless of a person's education, he or she preferred the old technology (paper) to the new (computer). Since this was a peripheral issue in this study, focused research into this area would be beneficial to those who provide innovations.

Conclusion

An overall analysis of the findings of this study makes it reasonable to conclude that paper-based and computer-based surveys can be considered equivalent in a voluntary self-report environment. Additionally, evidence shows that complexity and format differences between computer-based surveys do not significantly affect responses or response rates. Finally, the data suggests that it is improbable that significant bias was introduced into survey results based on survey method of administration, gender, or military commission.

Some additional and interesting observations were made. First, officers seemed to be affected by the survey medium more than other group. In particular, officers answered paper surveys at a statistically significant higher rate than computer surveys. Survey practitioners and academia should understand that officers, for unknown reasons

as of yet, respond better through the written medium. Consideration for this likelihood must be made, if a survey will include their responses.

A second observation, similar to the first observation, is that most groups responded better (higher response rate) to the paper survey as compared with the computer survey. As noted, the only significant difference was with officers, but the men and women groups had a consistently higher response rate for the paper surveys. The only group that did not have a higher response rate for paper surveys was enlisted personnel. However, the difference was a mere 2% meaning that both computer and paper surveys were equally used with no apparent prejudice for one form over the other. Practitioners should be aware that although there appears to be a prejudice overall for the paper survey over the computer survey, the data indicates that this does not cause significant bias in the survey data.

In summary, the use of computers to conduct surveys has been strengthened by this study. There are still many questions to be answered, but a step forward has been made by a careful and well-designed empirical study that has shown, contrary to the expected outcome, that there is very little difference between a similar paper and computer survey. Practitioners and academia can be more certain that computer surveys are not invalidating the future of survey research.

Appendix A: Paper Survey

SCN 00-34

Personnel Commitment Level Survey

Personal Information

1. Gender: O Male O Female
2. Rank: ____
3. AFSC: ____
4. Major Command: ____

5. Highest Education Level Completed:
   - O High School
   - O Some College
   - O Bachelor's Degree
   - O Master's Degree
   - O PhD

Optional Personal Information

6. Marital Status: O Single O Married
7. Number of Dependents: ____
8. Years at Residence: ____
9. Home of Record: ____

10. Household Yearly Gross Income:
    - O < $29,999
    - O $30,000 - $39,999
    - O $40,000 - $49,999
    - O $50,000 - $59,999
    - O > $60,000

Survey Instructions

Listed below are a series of statements that represent possible views that you might have about Air Force life. Please indicate the degree of your agreement or disagreement with each statement by choosing one of the five alternatives beside each statement.
1 = Disagree, 2 = Slightly disagree, 3 = Neutral, 4 = Slightly agree, 5 = Agree

Views about the Air Force	<< Disagree 1	2	3	4	Agree >> 5
1. I am willing to put in a great deal of effort beyond that normally expected in order to help the Air Force be successful.	O	O	O	O	O
2. I feel very little loyalty to the Air Force.	O	O	O	O	O
3. I find that my values and those of the Air Force are very similar.	O	O	O	O	O
4. I am proud to tell others that I am part of the Air Force	O	O	O	O	O
5. I am extremely glad that I chose the Air Force over other work opportunities I was considering at the time I joined.	O	O	O	O	O
6. There is little to be gained by staying in the Air Force until retirement.	O	O	O	O	O
7. I really care about the fate of the Air Force.	O	O	O	O	O
8. For me, this is the best of all possible organizations to work for.	O	O	O	O	O
9. I would accept almost any type of job assignment in order to keep working for the Air Force.	O	O	O	O	O
10. Deciding to join the Air Force was a definite mistake on my part.	O	O	O	O	O

Appendix B: Computer-simple Programming Code

Title: Computer Simple Code (surveycs.asp)
Name: Capt. Albert E. Franke IV
Date: 15 May 2000

```
<%ip= Request.ServerVariables("REMOTE_ADDR")%>
<HTML>
<HEAD>
<META http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<META NAME="GENERATOR" content="Microsoft FrontPage Express 2.0">
<TITLE>Survey</TITLE>
</HEAD>
<BODY bgcolor="#ffffff">
<DIV align=right><FONT FACE=Arial>SCN 00-34</FONT></DIV>
<CENTER><FONT FACE=Arial><FONT color=#000000 >
<STRONG>Personnel Commitment Level Survey</STRONG></FONT>
<FONT FACE=Arial>
<HR>
</FONT>
</CENTER>
<%
gender2 = Request.Form("gender1")
rank2 = Request.Form("rank1")
afsc2 = Request.Form("afsc1")
majcom2 = Request.Form("majcom1")
education2 = Request.Form("education1")
married2 = Request.Form("married1")
depends2 = Request.Form("depends1")
years2 = Request.Form("years1")
city2 = Request.Form("city1")
income2 = Request.Form("income1")
comments1 = Request.Form("comments")
q1 = Request.Form("1")
q2 = Request.Form("2")
q3 = Request.Form("3")
q4 = Request.Form("4")
q5 = Request.Form("5")
q6 = Request.Form("6")
q7 = Request.Form("7")
q8 = Request.Form("8")
q9 = Request.Form("9")
q10 = Request.Form("10")
if gender2 = "" OR rank2 = "" OR afsc2 = "" OR majcom2 = "" OR education2 = "" then
%>
<CENTER><FONT FACE=Arial>Personal Information<HR>
</FONT></CENTER>
<FORM ACTION="surveycs.asp" method="post">
<CENTER>
  <TABLE border=0>
    <TR>
```

```
        <TD height=15 style="HEIGHT: 15px"><FONT FACE=Arial>1. Gender: <INPUT
NAME=gender1 type=radio VALUE=Male> Male   <INPUT NAME=gender1
type=radio VALUE=Female> Female   </FONT></TD>
        <TD><FONT FACE=Arial>    </FONT></TD>
        <TD><FONT FACE=Arial>    </FONT></TD>
        <TD><FONT FACE=Arial>   </FONT></TD>
        <TD VALIGN=top><FONT FACE=Arial> 5. Highest
    Education Level Completed:  </FONT>
       </TD>
       </TR>
         <TR><TD>
    <P><FONT FACE=Arial>2. Rank: <INPUT NAME=rank1 size=10> </FONT> </P>
    <P><FONT FACE=Arial>3. AFSC: <INPUT NAME=afsc1 size=11> </FONT> </P><p><FONT
FACE=Arial>4. Major Command: <INPUT NAME=majcom1
  size=11></FONT></P>
         </TD>
         <TD><FONT FACE=Arial> </FONT></TD><TD><FONT FACE=Arial> 
</FONT>
    <P> </P></TD><TD><FONT FACE=Arial> </FONT></TD>
         <TD><FONT FACE=Arial><INPUT TYPE="radio" NAME=education1 VALUE="HS">
            High School<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="SC">
            Some College<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="B">
            Bachelor's Degree<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="M">
            Master's Degree<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="P">
            PhD</FONT>
            </TD>
         </TR>
  </TABLE>
  </CENTER><FONT FACE=Arial>
<HR>
</FONT>
<CENTER>
<FONT FACE=Arial>Optional Personal information</FONT>
<HR>
<DIV align=left> </DIV>
<TABLE border=0 style="HEIGHT: 154px; WIDTH: 700px" id=TABLE1>
<TR>
   <TD height=15 style="HEIGHT: 15px"><FONT
    FACE=Arial>6. Marital Status: <INPUT NAME=married1
    type=radio VALUE=Single> Single   <INPUT NAME=married1
    type=radio VALUE=Married> Married
    </FONT> </TD>
   <TD><FONT FACE=Arial>    </FONT> </TD>
   <TD><FONT FACE=Arial>    </FONT> </TD>
   <TD><FONT FACE=Arial>   </FONT> </TD>
   <TD VALIGN=top><FONT FACE=Arial> 10. Household Yearly Gross Income:
   </FONT>
   </TD></TR>
   <TR>
   <TD>
```

```
   <P><FONT FACE=Arial>7. Number of Dependents: <INPUT NAME=depends1 size=10> </FONT>
</P>
   <P><FONT FACE=Arial>8. Years at Residence: <INPUT NAME=years1 size=11> </FONT> </P>
   <P><FONT FACE=Arial>9. Home of Record: <INPUT NAME=city1 size=11></FONT></P></TD>
   <TD><FONT FACE=Arial> </FONT></TD>
   <TD><FONT FACE=Arial>  </FONT>
    <P> </P></TD>
   <TD><FONT FACE=Arial> </FONT></TD>
   <TD>
   <P><FONT FACE=Arial><INPUT
    NAME=income1 type=radio VALUE=30K>  &lt; $29,999<BR><INPUT
    NAME=income1 type=radio VALUE=40K> $30,000 - $39,999<BR><INPUT
    NAME=income1 type=radio VALUE=50K> $40,000 - $49,999<BR><INPUT
    NAME=income1 type=radio VALUE=60K> $50,000 - $59,999<BR><INPUT
    NAME=income1 type=radio VALUE=60KPlus> &gt;
    $60,000</FONT> </P></TD></TR>
</TABLE>
<HR>
Survey Instructions
</CENTER
<HR>
<CENTER><FONT FACE=Arial> Listed below are a series of statements that represent possible views
that you might have about Air Force life. Please indicate the degree of your agreement or disagreement
with each statement by choosing one of the five alternatives beside each statement.
<BR>1 = Disagree, 2 =  Slightly disagree, 3 = Neutral, 4 = Slightly agree, 5 = Agree</CENTER>
<FONT FACE=Arial>
<HR>
</FONT>
        <CENTER><TABLE border="1">
          <TR>
            <TD VALIGN="top" width="500"><p
            align="center"><FONT FACE=Arial><strong>Views about the Air
            Force</strong></FONT></P>
            </TD>
            <TD VALIGN="bottom" width="200">
    <DIV align=left><FONT FACE=Arial><FONT size=2><STRONG><FONT
    size=3> &lt;&lt;
    Disagree     Agree &gt;&gt;</FONT>
</STRONG> <BR></FONT>     1    &n
bsp; 2       3     &nbs
p; 4       5
    </FONT></DIV>
    </TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    1. I am willing to put in a great deal of effort beyond that normally expected in order to help the Air
    Force be successful.</FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    <INPUT NAME=1 type=radio
    VALUE=1>   <INPUT NAME=1 type=radio
VALUE=2>    <INPUT NAME=1
    type=radio VALUE=3>    <INPUT NAME=1 type=radio
    VALUE=4>    <INPUT NAME=1 type=radio VALUE=5></FONT></TD>
```

```
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    2. I feel very little loyalty to the Air Force. </FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
    <INPUT NAME=2 type=radio VALUE=1>   
    <INPUT NAME=2 type=radio VALUE=2>    
    <INPUT NAME=2 type=radio VALUE=3>    
    <INPUT NAME=2 type=radio VALUE=4>    
    <INPUT NAME=2 type=radio VALUE=5>
</FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    3. I find that my values and those of the Air Force are very similar.</FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
<INPUT NAME=3 type=radio  VALUE=1>   
<INPUT NAME=3 type=radio VALUE=2>    
<INPUT NAME=3 type=radio VALUE=3>    
<INPUT NAME=3 type=radio VALUE=4>    
<INPUT NAME=3 type=radio VALUE=5>
</FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    4. I am proud to tell others that I am part of the Air Force</FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
<INPUT NAME=4 type=radio VALUE=1>   
<INPUT NAME=4 type=radio VALUE=2>    
<INPUT NAME=4 type=radio VALUE=3>    
<INPUT NAME=4 type=radio VALUE=4>    
<INPUT NAME=4 type=radio VALUE=5></FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    5. I am extremely glad that I chose the Air Force over other work opportunities I was considering
    at the time I joined.</FONT>
    </TD>
     <td width="200"><FONT FACE=Arial>    
<INPUT NAME=5 type=radio VALUE=1>   
<INPUT NAME=5 type=radio VALUE=2>    
<INPUT NAME=5 type=radio VALUE=3>    
<INPUT NAME=5 type=radio VALUE=4>    
<INPUT NAME=5 type=radio VALUE=5></FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    6. There is little to be gained by staying in the Air Force until retirement. </FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
<INPUT NAME=6 type=radio VALUE=1>   
```

```
<INPUT NAME=6 type=radio VALUE=2>    
<INPUT NAME=6 type=radio VALUE=3>    
<INPUT NAME=6 type=radio VALUE=4>    
<INPUT NAME=6 type=radio VALUE=5>
</FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
   7. I really care about the fate of the Air Force.</FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
<INPUT NAME=7 type=radio VALUE=1>   
<INPUT NAME=7 type=radio VALUE=2>    
<INPUT NAME=7 type=radio VALUE=3>    
<INPUT NAME=7 type=radio VALUE=4>    
<INPUT NAME=7 type=radio VALUE=5></FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>8. For me, this is the
    best of all possible organizations to work for.</FONT>
    </TD>
     <td width="200"><FONT FACE=Arial>    
<INPUT NAME=8 type=radio VALUE=1>   
<INPUT NAME=8 type=radio VALUE=2>    
<INPUT NAME=8 type=radio VALUE=3>    
<INPUT NAME=8 type=radio VALUE=4>    
<INPUT NAME=8 type=radio VALUE=5></FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    9. I would accept almost any type of job assignment in order to keep working for the Air
    Force.</FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
<INPUT NAME=9 type=radio VALUE=1>   
<INPUT NAME=9 type=radio VALUE=2>    
<INPUT NAME=9 type=radio VALUE=3>    
<INPUT NAME=9 type=radio VALUE=4>    
<INPUT NAME=9 type=radio VALUE=5></FONT></TD>
    </TR>
    <TR>
    <td width="500"><FONT FACE=Arial>
    10. Deciding to join the Air Force was a definite mistake on my part. </FONT>
    </TD>
    <td width="200"><FONT FACE=Arial>    
<INPUT NAME=10 type=radio VALUE=1>   
<INPUT NAME=10 type=radio VALUE=2>    
<INPUT NAME=10 type=radio VALUE=3>    
<INPUT NAME=10 type=radio  VALUE=4>    
<INPUT NAME=10 type=radio VALUE=5></FONT></TD>
    </TR>
    </TABLE>
    </CENTER>
<CENTER> </CENTER>
```

```
<DIV align=left><FONT FACE=Arial>Do you have any additional Comments?
</FONT></DIV>
<DIV align=center><TEXTAREA id=comments NAME=comments style="HEIGHT: 62px; WIDTH:
664px"></TEXTAREA></DIV>
<p align="center">
<FONT FACE=Arial><INPUT TYPE="submit" VALUE="Submit answers">
</FONT> </P></TD></TR>
</TABLE>
</form>
<% else
msg_body = "Date: " & date & chr(13) & "Time: " & time & chr(13) & "IP: " & ip & chr(13) & "Gender: "
& gender2 & chr(13) & "Rank: " & rank2 & chr(13) & "AFSC: " & afsc2 & chr(13) & "MAJCOM: " &
majcom2 & chr(13) & "Education: " & education2 & chr(13) & "Married: " & married2 & chr(13) &
"Dependents: " & depends2 & chr(13) & "Years: " & years2 & chr(13) & "City: " & city2 & chr(13) &
"Income: " & income2 & chr(13) & "1. " & q1 & chr(13) & "2. " & q2 & chr(13) & "3. " & q3 & chr(13) &
"4. " & q4 & chr(13) & "5. " & q5 & chr(13) & "6. " & q6 & chr(13) & "7. " & q7 & chr(13) & "8. " & q8
& chr(13) & "9. " & q9 & chr(13) & "10. " & q10 & chr(13) & "comments: " & comments1 & chr(13)

' mail file
set objMail = Server.CreateObject("CDONTS.NewMail")
objMail.From = "albert.franke@afit.af.mil"
objMail.To = "albert.franke@afit.af.mil"
objMail.Subject = "Computer Survey Simple Results"
objMail.Body = msg_body
objMail.Send()
set objMail = nothing

' Place information into database
Set OBJdbConnection = Server.CreateObject("ADODB.Connection")
OBJdbConnection.Open "survey"
string1="INSERT INTO survey VALUES ("
sql = string1 & "'" & date & "','" & time & "','" & gender2 & "','" & rank2 & "','" & afsc2 & "','" &
majcom2 & "','" & education2 & "','" & married2 & "','" & depends2 & "','" & years2 & "','" & city2 & "','"
& income2 & "','" & q1 & "','" & q2 & "','" & q3 & "','" & q4 & "','" & q5 & "','" & q6 & "','" & q7 & "','" &
q8 & "','" & q9 & "','" & q10 & "','" & ip & "')"
OBJdbConnection.Execute(sql)
OBJdbConnection.close
%><font color="#ff0000" size="4" ></font>
<P align=center><font color="#ff0000" size="4" >
</font><FONT FACE=Arial> </FONT></P>
<P align=center><FONT color=#ff0000 FACE="Arial" size =4>Data sent! </FONT></P>
<P align=center><FONT color=#ff0000 size=4 >
<FONT FACE=Arial>Thank you for submitting your views on the Air Force.
<BR></FONT></P></FONT>
<% end if %>
</FONT>
</BODY>
</HTML>
```

Appendix C: Computer-complex Programming Code

Title: Computer Complex Code (surveycc.asp)
Name: Capt. Albert E. Franke IV
Date: 15 May 2000

```
<%ip=Request.ServerVariables("REMOTE_ADDR")
page1 = Request.Form("page")
if page1 = "" then
   page1 = "1"
end if
%>
<HTML>
<HEAD>
<TITLE>Survey</TITLE>
</HEAD>
<BODY bgcolor="#20b2aa">
<DIV align=right><font color="#000000" size="3" FACE=Arial>
SCN 00-34</font></DIV>
<CENTER><FONT FACE=Arial><FONT color=#000000 size=3>
<STRONG>Personnel Commitment Level Survey</STRONG></FONT> </FONT> <FONT
FACE=Arial>
<HR>
</FONT>
<FORM NAME = "form1" ACTION = "surveycc.asp" METHOD = post>
<%
select case page1
   case "1"
%>
</CENTER><CENTER><FONT FACE=Arial>Personal Information (page 1 of 3)<HR>
</FONT></CENTER>
  <CENTER>
  <INPUT NAME="page" VALUE="2" type=hidden>
  <TABLE border=0>
    <TR>
      <td height=15 style="HEIGHT: 15px"><FONT FACE=Arial>1. Gender:
      <INPUT TYPE="radio" NAME="gender1" VALUE="Male">
       Male  
      <INPUT TYPE="radio" NAME="gender1" VALUE="Female"> Female
        
      </FONT>
      </TD>
      <TD><FONT FACE=Arial>    </FONT>
      </TD>
      <TD><FONT FACE=Arial>    </FONT>
        </TD>
      <TD><FONT FACE=Arial>   </FONT>
        </TD>
        <TD VALIGN=top><FONT FACE=Arial> 5. Highest
   Education Level Completed:  </FONT>
        </TD>
      </TR>
      <TR>
```

```
        <TD>
    <P><FONT FACE=Arial>2. Rank:
    <SELECT id=rank1 NAME=rank1> <OPTION selected
     VALUE="None Selected">Select One</OPTION><OPTION
     VALUE=AB>Airman Basic</OPTION><OPTION VALUE=Amn>
     Airman</OPTION><OPTION VALUE=A1C>Airman First Class
    </OPTION><OPTION VALUE=SrA>Senior Airman</OPTION><OPTION VALUE=SSgt>Staff
Sergeant</OPTION><OPTION VALUE=TSgt>Technical Sergeant</OPTION><OPTION
VALUE=MSgt> Master Sergeant</OPTION><OPTION VALUE=SMSGT>Senior Master
Sergeant</OPTION><OPTION VALUE=CMSGT
    >Chief Master Sergeant</OPTION><OPTION VALUE=2Lt>Second Lieutenant
</OPTION><OPTION VALUE=1Lt>First Lieutenant</OPTION><OPTION
VALUE=Capt>Captain</OPTION><OPTION VALUE=Maj> major</OPTION> <OPTION
VALUE=LtCol>Lieutenant Colonel</OPTION><OPTION VALUE= Col>Colonel
</OPTION></SELECT>  </FONT> </P>
    <P><FONT FACE=Arial>3. AFSC: <INPUT NAME=afsc1 size=11> </FONT> </P>
    <P><FONT FACE=Arial>4. Major
    Command: <SELECT id=majcom1 NAME=majcom1> <OPTION selected
     VALUE="No Selection">Select One</OPTION><OPTION
     VALUE=ACC>ACC</OPTION><OPTION VALUE=AETC>AETC</OPTION><OPTION
     VALUE=AFMC>AFMC</OPTION><OPTION VALUE=AFSOC>AFSOC</OPTION><OPTION
     VALUE=AFSPC>AFSPC</OPTION><OPTION VALUE=AMC>AMC</OPTION><OPTION
     VALUE=PACAF>PACAF</OPTION><OPTION VALUE=USAFE>USAFE</OPTION><OPTION
     VALUE=Other>Other</OPTION></SELECT></FONT></P>
        </TD>
        <TD><FONT FACE=Arial> </FONT></TD><TD><FONT FACE=Arial> 
</FONT>
    <P> </P></TD><TD><FONT FACE=Arial> </FONT></TD>
        <TD>
    <P><FONT FACE=Arial><INPUT TYPE="radio" NAME=education1 VALUE="HS">
            High School<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="SC">
            Some College<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="B">
            Bachelor's Degree<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="M">
            Master's Degree<BR>
            <INPUT TYPE="radio" NAME=education1 VALUE="P"> PhD</FONT> </P>
    <P> </P>
            </TD>
        </TR>
  </TABLE>
  </CENTER>
<CENTER><INPUT TYPE = "submit" VALUE = "Next Page >" NAME = "Submit"></CENTER>
<CENTER> </CENTER>
<SCRIPT LANGUAGE="VBSCRIPT">
<!--
Function Submit_OnClick
Dim myForm
Set myForm = document.form1
Submit_OnClick=True
If (Not((myForm.gender1(0).checked) or (myForm.gender1(1).checked))) Then
  MsgBox "Please select a gender in Question 1",0,"Missing Information"
  Submit_OnClick = False
```

```
End If
If (myForm.rank1.value) = "None Selected" Then
  MsgBox "Please select a rank in Question 2",0,"Missing Information"
  Submit_OnClick = False
End If
If (myForm.afsc1.value) = "" Then
  MsgBox "Please enter an AFSC in Question 3",0,"Missing Information"
  Submit_OnClick = False
End If
If (myForm.majcom1.value) = "No Selection" Then
  MsgBox "Please select a MAJCOM in Question 4",0,"Missing Information"
  Submit_OnClick = False
End If
If (Not((myForm.education1(0).checked) or (myForm.education1(1).checked) or
(myForm.education1(2).checked) or (myForm.education1(3).checked) or
(myForm.education1(4).checked))) Then
  MsgBox "Please select an education level in Question 5",0,"Missing Information"
  Submit_OnClick = False
End If
End Function
-->
</SCRIPT>
</FORM>
<%
case "2"
gender2 = Request.Form("gender1")
rank2 = Request.Form("rank1")
afsc2 = Request.Form("afsc1")
majcom2 = Request.Form("majcom1")
education2 = Request.Form("education1")%>
<FONT FACE=Arial>
</FONT>
<CENTER><FONT FACE=Arial>Optional Personal Information (page 2 of
3)</FONT></CENTER><FONT FACE=Arial>
<CENTER>
<HR>
</FONT>
<INPUT NAME="page" VALUE="3" type=hidden>
<TABLE border=0 style="HEIGHT: 174px; WIDTH: 581px">
<TR>
  <TD height=15 style="HEIGHT: 15px">
   <P align=left><FONT FACE=Arial>6. Marital Status: <INPUT NAME=married1
   type=radio VALUE=Single> Single   <INPUT NAME=married1
   type=radio VALUE=Married> Married</FONT></P> </TD>
  <TD VALIGN=top>
   <P align=left><FONT FACE=Arial>10. Household Yearly Gross Income:
   </FONT></P>
    </TD></TR>
  <TR>
  <TD>
   <P align=left><FONT FACE=Arial>7. Number of Dependents: <INPUT NAME=depends1 size=10>
</FONT></P>
   <P align=left><FONT FACE=Arial>8. Years at Residence: <INPUT NAME=years1 size=11>
</FONT></P>
```

```
    <P align=left><FONT FACE=Arial>9. Home of Record: <INPUT NAME=city1
size=11></FONT></P></TD>
      <TD>
    <FONT FACE=Arial>
    <INPUT NAME=income1 type=radio VALUE=30K>&lt; $29,999<BR>
    <INPUT NAME=income1 type=radio VALUE=40K> $30,000 - $39,999<BR>
    <INPUT NAME=income1 type=radio VALUE=50K> $40,000 - $49,999<BR>
    <INPUT NAME=income1 type=radio VALUE=60K> $50,000 - $59,999<BR>
    <INPUT NAME=income1 type=radio VALUE=60KPlus> &gt; $60,000</FONT>
    <P> </P></TD></TR></TABLE><FONT FACE=Arial></FONT>
   <INPUT NAME="gender1" VALUE="<%=gender2%>" type=hidden>
   <INPUT NAME="rank1" VALUE="<%=rank2%>" type=hidden>
   <INPUT NAME="afsc1" VALUE="<%=afsc2%>" type=hidden>
   <INPUT NAME="majcom1" VALUE="<%=majcom2%>" type=hidden>
   <INPUT NAME="education1" VALUE="<%=education2%>" type=hidden>
<INPUT id=submit NAME=submit type=submit VALUE="Next Page >">
 <FONT FACE=Arial><p>
<SCRIPT LANGUAGE="VBSCRIPT">
<!--
Function Submit_OnClick
Dim myForm
Set myForm = document.form1
Submit_OnClick=True
If Len(myForm.depends1.value) > 0 Then
If (Not(IsNumeric(myForm.depends1.value))) Then
  MsgBox "Please only use numeric values for Question 7",0,"Missing Information"
  Submit_OnClick = False
End If
End If
If Len(myForm.years1.value) > 0 Then
If (Not(IsNumeric(myForm.years1.value))) Then
  MsgBox "Please only use numeric values for Question 8",0,"Missing Information"
  Submit_OnClick = False
End If
End If
End Function
-->
</SCRIPT>
</FORM>
<%case "3"
married2 = Request.Form("married1")
depends2 = Request.Form("depends1")
years2 = Request.Form("years1")
city2 = Request.Form("city1")
income2 = Request.Form("income1")
gender2 = Request.Form("gender1")
rank2 = Request.Form("rank1")
afsc2 = Request.Form("afsc1")
majcom2 = Request.Form("majcom1")
education2 = Request.Form("education1")
%>
</FONT>
<INPUT NAME="page" VALUE="4" type=hidden>
<p><FONT FACE=Arial>Survey Instructions (page 3 of 3)</FONT> </CENTER>
```

```
<FONT FACE=Arial>
<HR>
</FONT>
<CENTER><FONT FACE=Arial> Listed below
are a series of statements that represent possible views that you might have
about Air Force life. Please indicate the degree of your agreement or
disagreement with each statement by choosing one of the five alternatives
beside each statement.<BR>
1 = Disagree, 2 = Slightly disagree, 3 = Neutral, 4 = Slightly agree, 5 = Agree
</CENTER><FONT FACE=Arial>
        <HR>
</FONT>
        <CENTER><TABLE border="1">
          <TR>
            <TD VALIGN="top" width="500"><p
            align="center"><FONT FACE=Arial><strong>Views about the Air
            Force</strong></FONT></P>
            </TD>
            <TD VALIGN="bottom" width="200">
    <CENTER><STRONG>&lt;&lt;
    Disagree    Agree
&gt;&gt;</STRONG><BR> 1       2  &
nbsp;    3       4  &n
bsp;   5</CENTER>
             </TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>1.  I am willing to
    put in a great deal of effort beyond that normally expected in order to
    help the Air Force be successful.</FONT>
            </TD>
            <td width="200"><FONT FACE=Arial>    
<INPUT NAME=a1 type=radio VALUE=1>    
<INPUT NAME=a1 type=radio VALUE=2>    
<INPUT NAME=a1 type=radio VALUE=3>    
<INPUT NAME=a1 type=radio VALUE=4>    
<INPUT NAME=a1 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
          <td width="500"><FONT FACE=Arial>2.  I feel very
    little loyalty to the Air Force. </FONT>
              </TD>
            <td width="200"><FONT FACE=Arial>    <INPUT NAME=a2
type=radio
    VALUE=1>    <INPUT NAME=a2 type=radio
VALUE=2>    <INPUT NAME=a2
    type=radio VALUE=3>    <INPUT NAME=a2 type=radio
    VALUE=4>    <INPUT NAME=a2 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>3.  I find that my
    values and those of the Air Force are very similar.</FONT>
              </TD>
```

```
            <td width="200"><FONT FACE=Arial>    <INPUT NAME=a3
type=radio
    VALUE=1>    <INPUT NAME=a3 type=radio
VALUE=2>    <INPUT NAME=a3
    type=radio VALUE=3>    <INPUT NAME=a3 type=radio
    VALUE=4>    <INPUT NAME=a3 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>4.  I am proud to
    tell others that I am part of the Air Force</FONT>
                </TD>
            <td width="200"><FONT FACE=Arial>    <INPUT NAME=a4
type=radio
    VALUE=1>    <INPUT NAME=a4 type=radio
VALUE=2>    <INPUT NAME=a4
    type=radio VALUE=3>    <INPUT NAME=a4 type=radio
    VALUE=4>    <INPUT NAME=a4 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>5.  I am extremely glad
    that I chose the Air Force over other work opportunities I was considering
    at the time I joined.</FONT>
              </TD>
            <td width="200"><FONT FACE=Arial>    <INPUT NAME=a5
type=radio
    VALUE=1>    <INPUT NAME=a5 type=radio
VALUE=2>    <INPUT NAME=a5
    type=radio VALUE=3>    <INPUT NAME=a5 type=radio
    VALUE=4>    <INPUT NAME=a5 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>6.  There is little
    to be gained by staying in the Air Force until retirement. </FONT>
            </TD>
            <td width="200"><FONT FACE=Arial>    <INPUT NAME=a6
type=radio
    VALUE=1>    <INPUT NAME=a6 type=radio
VALUE=2>    <INPUT NAME=a6
    type=radio VALUE=3>    <INPUT NAME=a6 type=radio
    VALUE=4>    <INPUT NAME=a6 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>7.  I really care about
    the fate of the Air Force.</FONT>
              </TD>
            <td width="200"><FONT FACE=Arial>    <INPUT NAME=a7
type=radio
    VALUE=1>    <INPUT NAME=a7 type=radio
VALUE=2>    <INPUT NAME=a7
    type=radio VALUE=3>    <INPUT NAME=a7 type=radio
    VALUE=4>    <INPUT NAME=a7 type=radio VALUE=5></FONT></TD>
          </TR>
          <TR>
            <td width="500"><FONT FACE=Arial>8.  For me, this is
```

```
    the best of all possible organizations to work for.</FONT>
                </TD>
              <td width="200"><FONT FACE=Arial>    <INPUT NAME=a8
type=radio
    VALUE=1>    <INPUT NAME=a8 type=radio
VALUE=2>    <INPUT NAME=a8
    type=radio VALUE=3>    <INPUT NAME=a8 type=radio
    VALUE=4>    <INPUT NAME=a8 type=radio VALUE=5></FONT></TD>
            </TR>
            <TR>
              <td width="500"><FONT FACE=Arial>9.  I would accept
    almost any type of job assignment in order to keep working for the Air
    Force.</FONT>

                </TD>
              <td width="200"><FONT FACE=Arial>    <INPUT NAME=a9
type=radio
    VALUE=1>    <INPUT NAME=a9 type=radio
VALUE=2>    <INPUT NAME=a9
    type=radio VALUE=3>    <INPUT NAME=a9 type=radio
    VALUE=4>    <INPUT NAME=a9 type=radio VALUE=5></FONT></TD>
            </TR>
            <TR>
              <td width="500"><FONT FACE=Arial>10.  Deciding to
    join the Air Force was a definite mistake on my part. </FONT>
                  </TD>
              <td width="200"><FONT FACE=Arial>    <INPUT NAME=a10
type=radio
    VALUE=1>    <INPUT NAME=a10 type=radio
VALUE=2>    <INPUT NAME=a10
    type=radio VALUE=3>    <INPUT NAME=a10 type=radio
    VALUE=4>    <INPUT NAME=a10 type=radio
VALUE=5></FONT></TD>
            </TR>
          </TABLE>
          </CENTER>
<P align=left>Do you have any additional comments?<BR><CENTER><TEXTAREA id=comments
NAME=comments style="HEIGHT: 75px; WIDTH: 667px"></TEXTAREA> </CENTER>
<P></P>
<P align=left>
            <INPUT NAME="gender1" VALUE="<%=gender2%>" type=hidden>
   <INPUT NAME="rank1" VALUE="<%=rank2%>" type=hidden>
   <INPUT NAME="afsc1" VALUE="<%=afsc2%>" type=hidden>
   <INPUT NAME="majcom1" VALUE="<%=majcom2%>" type=hidden>
   <INPUT NAME="education1" VALUE="<%=education2%>" type=hidden>
   <INPUT NAME="married1" VALUE="<%=married2%>" type=hidden>
   <INPUT NAME="depends1" VALUE="<%=depends2%>" type=hidden>
   <INPUT NAME="city1" VALUE="<%=city2%>" type=hidden>
   <INPUT NAME="income1" VALUE="<%=income2%>" type=hidden>
   <INPUT NAME="years1" VALUE="<%=years2%>" type=hidden> </P>
 <DIV></DIV>
<P align=center><FONT FACE=Arial><INPUT TYPE="submit" VALUE="Submit answers" id=submit
NAME=submit>
</FONT></P></TD></TR></TABLE>
```

```
<DIV></DIV>
<SCRIPT LANGUAGE="VBSCRIPT">
<!--
Function Submit_OnClick

Dim myForm
Set myForm = document.form1
Submit_OnClick=True
If (Not((myForm.a1(0).checked) or (myForm.a1(1).checked) or (myForm.a1(2).checked) or
(myForm.a1(3).checked) or (myForm.a1(4).checked))) Then
  MsgBox "Please select an option for Question 1",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a2(0).checked) or (myForm.a2(1).checked) or (myForm.a2(2).checked) or
(myForm.a2(3).checked) or (myForm.a2(4).checked))) Then
  MsgBox "Please select an option for Question 2",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a3(0).checked) or (myForm.a3(1).checked) or (myForm.a3(2).checked) or
(myForm.a3(3).checked) or (myForm.a3(4).checked))) Then
  MsgBox "Please select an option for Question 3",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a4(0).checked) or (myForm.a4(1).checked) or (myForm.a4(2).checked) or
(myForm.a4(3).checked) or (myForm.a4(4).checked))) Then
  MsgBox "Please select an option for Question 4",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a5(0).checked) or (myForm.a5(1).checked) or (myForm.a5(2).checked) or
(myForm.a5(3).checked) or (myForm.a5(4).checked))) Then
  MsgBox "Please select an option for Question 5",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a6(0).checked) or (myForm.a6(1).checked) or (myForm.a6(2).checked) or
(myForm.a6(3).checked) or (myForm.a6(4).checked))) Then
  MsgBox "Please select an option for Question 6",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a7(0).checked) or (myForm.a7(1).checked) or (myForm.a7(2).checked) or
(myForm.a7(3).checked) or (myForm.a7(4).checked))) Then
  MsgBox "Please select an option for Question 7",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a8(0).checked) or (myForm.a8(1).checked) or (myForm.a8(2).checked) or
(myForm.a8(3).checked) or (myForm.a8(4).checked))) Then
  MsgBox "Please select an option for Question 8",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a9(0).checked) or (myForm.a9(1).checked) or (myForm.a9(2).checked) or
(myForm.a9(3).checked) or (myForm.a9(4).checked))) Then
  MsgBox "Please select an option for Question 9",0,"Missing Information"
  Submit_OnClick = False
ElseIf (Not((myForm.a10(0).checked) or (myForm.a10(1).checked) or (myForm.a10(2).checked) or
(myForm.a10(3).checked) or (myForm.a10(4).checked))) Then
  MsgBox "Please select an option for Question 10",0,"Missing Information"
  Submit_OnClick = False
End If
End Function
-->
</SCRIPT>
</FORM>
<%
```

```
case "4"
q1 = Request.Form("a1")
q2 = Request.Form("a2")
q3 = Request.Form("a3")
q4 = Request.Form("a4")
q5 = Request.Form("a5")
q6 = Request.Form("a6")
q7 = Request.Form("a7")
q8 = Request.Form("a8")
q9 = Request.Form("a9")
q10= Request.Form("a10")
married2 = Request.Form("married1")
depends2 = Request.Form("depends1")
years2 = Request.Form("years1")
city2 = Request.Form("city1")
income2 = Request.Form("income1")
gender2 = Request.Form("gender1")
rank2 = Request.Form("rank1")
afsc2 = Request.Form("afsc1")
majcom2 = Request.Form("majcom1")
education2 = Request.Form("education1")
comments1 = Request.Form("comments")

msg_body = "Date: " & date & chr(13) & "Time: " & time & chr(13) & "IP: " & ip & chr(13) & "Gender: "
& gender2 & chr(13) & "Rank: " & rank2 & chr(13) & "AFSC: " & afsc2 & chr(13) & "MAJCOM: " &
majcom2 & chr(13) & "Education: " & education2 & chr(13) & "Married: " & married2 & chr(13) &
"Dependents: " & depends2 & chr(13) & "Years: " & years2 & chr(13) & "City: " & city2 & chr(13) &
"Income: " & income2 & chr(13) & "1. " & q1 & chr(13) & "2. " & q2 & chr(13) & "3. " & q3 & chr(13) &
"4. " & q4 & chr(13) & "5. " & q5 & chr(13) & "6. " & q6 & chr(13) & "7. " & q7 & chr(13) & "8. " & q8
& chr(13) & "9. " & q9 & chr(13) & "10. " & q10 & chr(13) & "comments: " & comments1 & chr(13)

' mail file
set objMail = Server.CreateObject("CDONTS.NewMail")
objMail.From = "albert.franke@afit.af.mil"
objMail.To = "albert.franke@afit.af.mil"
objMail.Subject = "Computer Survey Dis-Similar Results"
objMail.Body = msg_body
objMail.Send()
set objMail = nothing

' Place information into database
Set OBJdbConnection = Server.CreateObject("ADODB.Connection")
OBJdbConnection.Open "survey"
string1="INSERT INTO survey2 VALUES ("
sql = string1 & "'" & date & "','" & time & "','" & gender2 & "','" & rank2 & "','" & afsc2 & "','" &
majcom2 & "','" & education2 & "','" & married2 & "','" & depends2 & "','" & years2 & "','" & city2 & "','"
& income2 & "','" & q1 & "','" & q2 & "','" & q3 & "','" & q4 & "','" & q5 & "','" & q6 & "','" & q7 & "','" &
q8 & "','" & q9 & "','" & q10 & "','" & ip & "')"
OBJdbConnection.Execute(sql)
OBJdbConnection.close

%><font color="#ff0000" size="4" ></font>
<P align=center><font color="#ff0000" size="4" >
```

```
</font><FONT FACE=Arial> </FONT><FONT color=#ff0000 FACE="Wide Latin"
size=4><FONT color=#ff0000 FACE="Wide Latin" size=4></FONT></FONT></P>
<P align=center><FONT color=#ff0000 FACE="Wide Latin" size=4><FONT color=#ff0000
FACE="Wide Latin" size=4>Data sent!   </FONT></P>
<P align=center><FONT color=#ff0000 FACE="Wide Latin" size=4>Thank you for
submitting your views on the Air Force.</FONT></P></FONT></FONT></BODY>
</HTML>
<%
end select

Function Strip(var)
variable=Instr(var,"'")
if variable <> 0 then
   Strip=" "
else
   Strip=var
end if
End Function
%>
```

Appendix B: Detailed Survey Answer Analysis

1. I am willing to put in a great deal of effort beyond that normally expected in order to help the Air Force be successful.

Question 1 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	4.181818	0.954134	5	
Computer-simple	126	4.268293	0.923936	5	
Computer-complex	116	4.155172	0.938115	4	1 = Disagree
Men: Paper	67	4.223881	0.884563	5	
Computer-simple	53	4.054407	1.002271	4	2 = Slightly Disagree
Computer-complex	64	4.296875	0.885145	5	
Women: Paper	76	4.144737	1.015926	5	3= Neutral
Computer-simple	73	4.385714	0.905584	5	
Computer-complex	52	3.980769	0.980004	4	4= Slightly Agree
Officer: Paper	88	4.318182	0.878157	5	
Computer-simple	66	4.421875	0.831993	5	5= Agree
Computer-complex	68	4.117647	0.832011	4	
Enlisted: Paper	55	3.963636	1.035725	4	
Computer-simple	60	4.109375	0.961434	4	
Computer-complex	48	4.212766	1.082191	5	

2. I feel very little loyalty to the Air Force.

Question 2 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	2.090909	1.352666	1	
Computer-simple	126	2.073171	1.415203	1	
Computer-complex	116	2.103448	1.281163	1	1 = Disagree
Men: Paper	67	2.044776	1.319238	1	
Computer-simple	53	2.116344	1.339395	1	2 = Slightly Disagree
Computer-complex	64	2.125000	1.290994	1	
Women: Paper	76	2.131579	1.388929	1	3= Neutral
Computer-simple	73	2.014286	1.459530	1	
Computer-complex	52	2.076923	1.281025	1	4= Slightly Agree
Officer: Paper	88	1.931818	1.362852	1	
Computer-simple	66	1.843750	1.324000	1	5= Agree
Computer-complex	68	1.985294	1.070610	1	
Enlisted: Paper	55	2.345455	1.308352	1	
Computer-simple	60	2.265625	1.439160	1	
Computer-complex	48	2.234043	1.521052	1	

3. I find that my values and those of the Air Force are very similar.

Question 3 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	3.86014	1.091590	4	
Computer-simple	126	3.869919	1.023970	4	
Computer-complex	116	3.887931	0.920978	4	1 = Disagree
Men: Paper	67	3.731343	1.162313	4	
Computer-simple	53	3.855549	1.051493	4	2 = Slightly Disagree
Computer-complex	64	3.937500	0.833333	4	
Women: Paper	76	3.973684	1.019460	4	3= Neutral
Computer-simple	73	3.842857	1.044457	4	
Computer-complex	52	3.826923	1.023664	4	4= Slightly Agree
Officer: Paper	88	4.079545	0.937367	4	
Computer-simple	66	4.046875	0.982864	4	5= Agree
Computer-complex	68	3.985294	0.717282	4	
Enlisted: Paper	55	3.509091	1.230368	5	
Computer-simple	60	3.703125	1.002848	4	
Computer-complex	48	3.723404	1.136396	4	

4. I am proud to tell others that I am part of the Air Force.

Question 4 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	4.454545	0.861764	5	
Computer-simple	126	4.479675	0.761250	5	
Computer-complex	116	4.310345	0.936355	5	1 = Disagree
Men: Paper	67	4.462687	0.784864	5	
Computer-simple	53	4.307013	0.942649	5	2 = Slightly Disagree
Computer-complex	64	4.390625	0.847352	5	
Women: Paper	76	4.447368	0.929441	5	3= Neutral
Computer-simple	73	4.571429	0.693059	5	
Computer-complex	52	4.211538	1.035385	5	4= Slightly Agree
Officer: Paper	88	4.556818	0.755941	5	
Computer-simple	66	4.671875	0.592404	5	5= Agree
Computer-complex	68	4.308824	0.848749	5	
Enlisted: Paper	55	4.290909	0.993921	5	
Computer-simple	60	4.312500	0.852168	5	
Computer-complex	48	4.319149	1.065392	5	

5. I am extremely glad that I chose the Air Force over other work opportunities I was considering at the time I joined.

Question 5 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	4.027972	1.150285	5	
Computer-simple	126	4.130081	1.115901	5	
Computer-complex	116	3.982759	1.172012	5	1 = Disagree
Men: Paper	67	4.014925	1.199653	5	
Computer-simple	53	3.895480	1.251248	5	2 = Slightly Disagree
Computer-complex	64	4.093750	1.094267	5	
Women: Paper	76	4.039474	1.112844	5	3= Neutral
Computer-simple	73	4.285714	1.009274	5	
Computer-complex	52	3.846154	1.258456	5	4= Slightly Agree
Officer: Paper	88	4.068182	1.048211	5	
Computer-simple	66	4.250000	1.069045	5	5= Agree
Computer-complex	68	3.911765	1.115649	5	
Enlisted: Paper	55	3.963636	1.304744	5	
Computer-simple	60	4.046875	1.132909	5	
Computer-complex	48	4.085106	1.265423	5	

6. There is little to be gained by staying in the Air Force until retirement.

Question 6 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	2.559441	1.417309	1	
Computer-simple	126	2.463415	1.380738	1	
Computer-complex	116	2.629310	1.288951	2	1 = Disagree
Men: Paper	67	2.462687	1.363244	2	
Computer-simple	53	2.587715	1.268856	2	2 = Slightly Disagree
Computer-complex	64	2.500000	1.247219	2	
Women: Paper	76	2.644737	1.467006	1	3= Neutral
Computer-simple	73	2.342857	1.443483	1	
Computer-complex	52	2.788462	1.333380	4	4= Slightly Agree
Officer: Paper	88	2.386364	1.393184	1	
Computer-simple	66	2.218750	1.314978	1	5= Agree
Computer-complex	68	2.544118	1.157834	2	
Enlisted: Paper	55	2.836364	1.424178	1	
Computer-simple	60	2.671875	1.392208	1	
Computer-complex	48	2.744681	1.466556	1	

7. I really care about the fate of the Air Force.

Question 7 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	4.335664	0.956402	5	
Computer-simple	126	4.317073	0.880732	5	
Computer-complex	116	4.129310	0.982722	5	1 = Disagree
Men: Paper	67	4.373134	0.950850	5	
Computer-simple	53	4.108921	1.023980	5	2 = Slightly Disagree
Computer-complex	64	4.250000	0.992032	5	
Women: Paper	76	4.302632	0.966364	5	3= Neutral
Computer-simple	73	4.442857	0.810005	5	
Computer-complex	52	3.980769	0.959787	4	4= Slightly Agree
Officer: Paper	88	4.500000	0.896994	5	
Computer-simple	66	4.500000	0.734631	5	5= Agree
Computer-complex	68	4.191176	0.814929	5	
Enlisted: Paper	55	4.072727	0.997303	5	
Computer-simple	60	4.140625	0.957298	5	
Computer-complex	48	4.063830	1.186963	5	

8. For me, this is the best of all possible organizations to work for.

Question 8 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	3.251748	1.207188	4	
Computer-simple	126	3.495935	1.282761	4	
Computer-complex	116	3.155172	1.205808	4	1 = Disagree
Men: Paper	67	3.208955	1.174699	3	
Computer-simple	53	3.062035	1.384033	4	2 = Slightly Disagree
Computer-complex	64	3.171875	1.254259	4	
Women: Paper	76	3.289474	1.241674	4	3= Neutral
Computer-simple	73	3.814286	1.094027	4	
Computer-complex	52	3.134615	1.155190	3	4= Slightly Agree
Officer: Paper	88	3.295455	1.146299	4	
Computer-simple	66	3.312500	1.307791	4	5= Agree
Computer-complex	68	3.102941	1.182423	4	
Enlisted: Paper	55	3.181818	1.306549	3	
Computer-simple	60	3.687500	1.206793	4	
Computer-complex	48	3.276596	1.210500	4	

9. I would accept almost any type of job assignment in order to keep working for the Air Force.

Question 9 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	2.307692	1.234657	1	
Computer-simple	126	2.609756	1.364864	1	
Computer-complex	116	2.336207	1.291739	1	1 = Disagree
Men: Paper	67	2.223881	1.228708	1	
Computer-simple	53	2.424669	1.297548	1	2 = Slightly Disagree
Computer-complex	64	2.343750	1.359490	1	
Women: Paper	76	2.381579	1.243298	1	3= Neutral
Computer-simple	73	2.714286	1.405402	1	
Computer-complex	52	2.326923	1.216249	1	4= Slightly Agree
Officer: Paper	88	2.386364	1.263382	1	
Computer-simple	66	2.750000	1.368582	1	5= Agree
Computer-complex	68	2.323529	1.263799	1	
Enlisted: Paper	55	2.181818	1.187760	1	
Computer-simple	60	2.500000	1.356934	2	
Computer-complex	48	2.382979	1.344121	1	

10. Deciding to join the Air Force was a definite mistake on my part.

Question 10 Responses	*N*	Mean	Standard Deviation	Mode	
Overall: Paper	143	1.566434	1.017865	1	
Computer-simple	126	1.471545	0.952350	1	
Computer-complex	116	1.663793	1.149245	1	1 = Disagree
Men: Paper	67	1.552239	1.004288	1	
Computer-simple	53	1.528488	1.023904	1	2 = Slightly Disagree
Computer-complex	64	1.562500	1.021592	1	
Women: Paper	76	1.578947	1.036187	1	3= Neutral
Computer-simple	73	1.414286	0.876304	1	
Computer-complex	52	1.788462	1.288509	1	4= Slightly Agree
Officer: Paper	88	1.511364	0.982541	1	
Computer-simple	66	1.453125	0.941625	1	5= Agree
Computer-complex	68	1.705882	1.154331	1	
Enlisted: Paper	55	1.654545	1.075281	1	
Computer-simple	60	1.500000	0.942809	1	
Computer-complex	48	1.595745	1.154567	1	

Bibliography

Adams, Heather L. Air Force Media Use and Conformance with Media Richness Theory: Implications for E-mail Use and Policy. Unpublished MS thesis, AFIT/GIR/LAR/96D-1. School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, December 1996.

Air Force Personnel Center, FY2000 first quarter demographic report as published in Wright-Patterson AFB, Skywrighter newspaper (3 March 2000).

Arbaugh, J. B. "Virtual Classroom Versus Physical Classroom: An Exploratory Study," Journal of Management Education 24(2): 213-234 (2000).

Babbie, E. Survey Research Methods, 2nd Ed. Belmont, Ca: Wadsworth Inc., 1990.

Beaton, A. E. & R. Zwick. The Effect of Changes in the National Assessment: Disentangling the NAEP 1985-86 Reading Anomoly. Princeton, NJ: Educational Testing Service (ETS), 1990.

Booth-Kewley, S., J. E. Edwards, & P. Rosenfeld. "Impression Management, Social Desirability, and Computer Administration of Attitude Questionnaires: Does the Computer Make a Difference?" Journal of Applied Psychology,77: 562-566 (1992).

Brennan, R.L. Elements of Generalizability theory. Iowa City, Iowa: ACT Publications, 1983.

Canada, K. & F. Brusca. "The Technological Gender Gap: Evidence and Recommendations for Educators and Computer-Based Instruction Designers," Educational Technology Research and Development, 39(2): 43-51 (1991).

Cizek, G. J. "The Effect of Altering the Position of Options in a Multiple-choice Examination," Educational and Psychological Measurement, 54(1): 8-20 (1994).

Comley, P. "The Use of the Internet as a Data Collection Method," In a SGA ESCOMAR Paper, http://www.sga.co.uk/esomar.html: 1-8 (2000).

Cotton, C. C. "Social Class as a Neglected variable in Organizational Behavior." Journal of Psychology Interdisciplinary & Applied 128(4): 409-418 (July 1994).

Cronbach, L. J. "Response Sets and Test Validity," Educational and Psychological Measurement, 6: 475-495 (1946).

Cronbach, L. J., F. C. Glaser, H. Nanda & N. Rajaratnam. The dependability of behavioral measurements: Theory of generizability for scores and profiles. New York: Wiley, 1972.

Davis, F. D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," MIS Quarterly 13(3): 319-339 (1989).

Dooley, David. Social Research Methods-3rd Ed. New Jersey: Prentice Hall, Inc., 1995.

Edwards, P. N. "The Army and The Microworld: Computers and the Politics of Gender Identity," Signs, 16(1): 102-127 (1990).

Evan, W. M., & J. R. Miller. "Differential Effects on Response Bias of Computer Vs. Conventional Administration of a Social Science Questionnaire: An Exploratory Methodological Experiment," Behavioral Science, 14: 216-227 (1969)

Fowler, F. J., Jr. Survey Research Methods. Newbury Park, CA: Sage Publications, Inc., 1988.

Gefen, D. & D. Straub, "Gender Differences in the Perception and Use of E-mail: An Extension to the Technology Acceptance Model," MIS Quarterly: 389-399 (December 1997).

George, C. E., J. S. Lankford & S. E. Wilson. "The Effects of Computerized Versus Paper-and-Pencil Administration on Measures of Negative Effect," Computers in Human Behavior, 8: 203-209 (1992).

Ghiselli, E. E. Theory of Psychological Measurement. New York: McGraw Hill, 1964.

Higgins, N. & L. Hess. "Using Electronic Books to Promote Vocabulary Development," Journal of Research on Computing in Education 31(4): 425-431 (1999).

Hochstim, J. R. "A Critical Comparison of Three Strategies of Collecting Data From Households," Journal of the American Statistical Association, 62: 976-989 (1967).

Hofer, P. J., B. F. Green. "The Challenge of Competence and Creativity in Computerized Psychological Testing," Journal of Consulting and Clinical Psychology, 53(6): 826-838 (1985).

Honaker, L. M. "The Equivalency of Computerized and Conventional MMPI Administration: A Critical Review," Clinical Psychology Review, 9: 561-577 (1988).

Horney, M. A. & L. Anderson-Inman. "Supported Text in Electronic Reading Environments," Reading & Writing Quarterly 15(2): 127-179 (1999).

Hufnagel E. M. & C. Conca. "User Response Data: The Potential for Errors and Biases," Information Systems Research 5(1): 48-73 (1994).

Hyman, H. Survey Design and Analysis. The Free Press on Glencoe, 1963.

Jaffe A. J. & H. F. Spirer. Misused Statistics. New York: Marcel Dekker, Inc., 1987.

James, Michael L. & E. C. Wotring. "An Exploratory Study of the Perceived Benefits of Electronic Bulletin Board Use and Their Impact," Journal of Broadcasting & Electronic Media 39(1): 30-51 (1995).

Kawasaki, J. L. & M. R. Raven. "Computer-administered Surveys in Extension," Journal of Extension, 33(3): (June 1995).

Kiesler, S. & L. S. Sproull. "Response Effects in the Electronic Survey," Public Opinion Quarterly, 50: 402-413 (1986).

Kramer, P. E., S. Lehman. "Mismeasuring Women: A Critique of Research on Computer Ability and Avoidance," Signs, 16(1): 158-172 (1990).

Lautenschlager, G. J., & V. L. Flaherty. "Computer Administration of Questions: More Desirable or More Social Desirability," Journal of Applied Psychology, 75: 310-314 (1990).

McClave, James T. Statistics for Business and Economics-7th Ed. New Jersey: Prentice Hall, Inc., 1998.

Mowday, R. T., R. M. Steers, & L. W. Porter. "The Measurement of Organizational Commitment," Journal of Vocational Behavior, 14: 224-247 (1979).

Parten, M. Surveys, Polls, and Samples: Practical Procedures. New York: Harper & Brothers Publishers, 1950.

Paulhus, D. L. "Measurement and Control of Response Bias," In J. P. Robinson, AP. R. Shaver, & L. S. Wrightsman (Eds.), Measures of Personality and Social Psychological Attitudes. San Diego, CA: Academic Press, 17-59 (1991).

Pinsoneault, T. B. "Equivalency of Computer-Assisted and Paper-and-Pencil Administered Versions of the Minnesota Multiphasic Personality Inventory-2," Computers in Human Behavior, 12(2): 291-300 (1996).

Rempel, J. K., & J. G. Holmes. "How do I trust thee?" Psychology Today: 28-34 (February 1986).

Reichard, R. J. "The Effects of Computers in Surveys," http://clearinghouse.mwsc.edu/manuscripts/117.asp (1998).

Regan, Tom. "Electronic Books Almost Ready For Switch On," Christian Science Monitor 92(200): 18 (2000).

Rogers, Everett M. Diffusion of Innovations: 4th Ed. New York: Free Press, 1995.

Rogers, T. F. "Interviews by telephone and in person; quality of responses and field performance," Public Opinion Quarterly, 40: 51-65 (1976).

Rosenfeld, P., L. M. Doherty, S. M. Vicino, J. Kantor, & J. Greaves. "Attitude Assessment in Organizations: Testing Three Microcomputer-based Survey Systems," Journal of General Psychology, 116: 145-154 (1989).

Rosenfeld, P., R. A. Giacalone, S. B. Knouse, L. M. Doherty, S. M. Vicino, J. Kantor, & J. Greaves. "Impression Management, Candor, and Microcomputer-Based Organizational Surveys: An Individual Difference Approach," Computers in Human Behavior, 7: 23-32 (1991).

Rosenfeld, P. & S. Booth-Kewely. "Computer-Administered Surveys in Organizational Settings," American Behavioral Scientist, 36(4): 485-512 (1993).

Schuldberg, D. "The MMPI is Less Sensitive to the Automated Testing Format than it is to Repeated Testing: Item and Scale Effects," Computers in Human Behavior, 4: 285-298 (1988).

Singer, E. & S. Presser. Survey Research Methods. Chicago: The University of Chicago Press, 1989.

Sjostrom, O., D. Holst, & S. O. Lind. "Validity of a Questionnaire Survey: The Role of Non-Response and Incorrect Answers," Acta Odontologica Scandinavica, 57(5): 242-246 (1999).

Straub, D. W. "Validating Instruments in MIS Research," MIS Quarterly: 147-165 (June 1989).

Venkatesh, V. & M. G. Morris. "Why Don't Men Ever Stop To Ask For Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior," MIS Quarterly 24(1): 115-139 (March 2000).

Webster, J. & D. Compeau. "Computer-Assisted Versus Paper-and-Pencil Administration of Questionnaires," Behavior Research Methods, Instruments, & Computers, 28(4): 567-576 (1996).

Whitley, B. E. "Gender Differences in Computer-Related Attitudes: It Depends on What You Ask," Computers in Human Behavior, 12(2): 275-289 (1996).

Wilson F. R., K. T. Genco, & G. G. Yager. "Assessing the Equivalence of Paper-and-pencil vs. Computerized Tests: Demonstration of a Promising Methodology," Computers in Human Behavior, 1: 265-275 (1985).

Wiseman, Frederick. "Methodological bias in public opinion surveys," Public Opinion Quarterly, 36(1): (1972).

Vita

Captain Albert E. Franke IV was born on [redacted] in Camden, New Jersey. He graduated from Mission Bay High School in San Diego, California in June 1988. He enlisted in the Air Force in March 1991 and was stationed at Randolph AFB, Texas from August 1991 to January 1996 as a computer programmer. While there he entered undergraduate studies at Texas Lutheran College near San Antonio, Texas where he graduated summa cum laude with a Bachelor of Arts degree in Management Information Systems in December 1994. He was commissioned through Officer Training School Class 96-04 at Maxwell AFB, Alabama in May 1996.

His first assignment after graduation from Basic Communications Officer Training in September 1996 was to Ramstein AB, Germany working in USAFE Computer System Squadron as the OIC, Web Technology Support. In August 1998, he was assigned to USAFE Air Postal Squadron as the logistics flight commander. In August 1999, he entered the Graduate School of Engineering and Management, Air Force Institute of Technology. Upon graduation, he will be assigned to the Directorate of Communication and Information, HQ Air Force Space Command, Peterson AFB, Colorado.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
20-03-2001	Master's Thesis	Aug 1999 – Mar 2001

4. TITLE AND SUBTITLE

COMPARATIVE ANALYSIS OF TRADITIONAL VERSUS COMPUTER-BASED SURVEY INSTRUMENT RESPONSE

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Franke, Albert E. IV, Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 P Street, Building 640
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GIR/ENV/01M-08

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

HQ AFPC/DPSAS
Attn: Mr. Charles Hamilton
550 C Street West
Randolph AFB TX 78150 DSN: 665-2448

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The purpose of this study was to determine if survey medium (paper versus computer) affected responses and response rates in Air Force personnel. The study compared responses and response rates from 900 randomly selected Air Force active-duty members using a paper-based survey, a computer-based survey, and a more complex computer-based survey. The first computer-based survey minimized the differences between itself and the paper-based survey to more accurately quantify any bias due solely to the computer medium. The more complex survey served to maximize differences between itself and the other computer-based survey to more accurately quantify any bias due to programmatic complexity. In addition, responses from groups stratified on gender (men and women) and military commission (officers and enlisted) were compared between the three survey types. The results showed that no statistically significant differences could be detected between the paper and computer surveys overall and for men, women, officer, and enlisted personnel. In the context of non-sensitive, organizational research, paper and computer surveys can be considered equivalent research mediums with regard to reliability and validity.

15. SUBJECT TERMS

Surveys, Questionnaires, Organizational Research, Survey Validity, Survey Reliability, Survey Equivalency

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Maj Mark A. Ward, ENV
U	U	U	UU	102	19b. TELEPHONE NUMBER *(Include area code)* (937) 255-3636, ext 3329)

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

Form Approved
OMB No. 074-0188